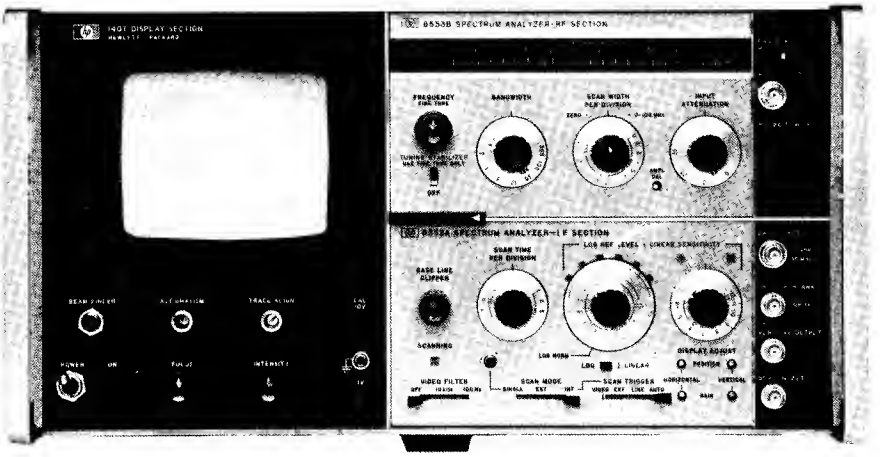
OPERATING AND SERVICE MANUAL

DISPLAY SECTION
140T



HEWLETT hp PACKARD

CERTIFICATION

The Hewlett-Packard Company certifies that this instrument was thoroughly tested and inspected and found to meet its published specifications when it was shipped from the factory. The Hewlett-Packard Company further certifies that its calibration measurements are traceable to the U.S. National Bureau of Standards to the extent allowed by the Bureau's calibration facility.

WARRANTY AND ASSISTANCE

This Hewlett-Packard product is warranted against defects in materials and workmanship. This warranty applies for one year from the date of delivery, or, in the case of certain major components listed in the operating manual, for the specified period. We will repair or replace products which prove to be defective during the warranty period provided they are returned to Hewlett-Packard. No other warranty is expressed or implied. We are not liable for consequential damages.

Service contracts or customer assistance agreements are available for Hewlett-Packard products that require maintenance and repair on-site.

For any assistance, contact your nearest Hewlett-Packard Sales and Service Office. Addresses are provided at the back of this manual.

OPERATING AND SERVICE MANUAL

MODEL 140T
DISPLAY SECTION

SERIALS PREFIXED: 948–

Refer to Section VII for instruments with other Serial Prefixes.

HEWLETT-PACKARD COMPANY/COLORADO SPRINGS DIVISION
1900 GARDEN OF THE GODS ROAD, COLORADO SPRINGS, COLORADO, U.S.A.

PRINTED: MAR 1970

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Table 1-1. Specifications

PLUG-INS:

Accepts Model 8500-series RF and IF Section spectrum analyzer plug-ins without the use of a center divider shield.

Also accepts all Model 1400-series plug-ins. All plug-ins operate directly into the CRT horizontal and vertical deflection plates. Center shield may be removed to provide double-sized compartment for use with a single dual axis Model 1400-series unit.

CATHODE-RAY TUBE:

Type:
Post-accelerator, 7300-volt accelerating potential, aluminized P31 phosphor standard etched safety glass face plate reduces glare.

Graticule:
8 x 10 div, parallax-free internal graticule, marked in centimeter squares; subdivisions of 2 mm on major horizontal and vertical axes. Transparent coating to reduce RFI.

Intensity Modulation:
AC coupled; +20-volt signal will blank trace of normal intensity; input terminals and switch on rear panel.

Writing Speed:
(Using HP Model 197A Camera with f/1.9 lens and Polaroid® 3000 speed film).

P31 Phosphor: 250 div/usec.

CALIBRATOR:

Type:
Line-frequency rectangular signal, approximately 0.5 usec risetime.

Voltage:
Two outputs: 1 volt and 10 volts peak-to-peak, ±1% from 15°C to 35°C; ±3%, 0°C to 55°C.

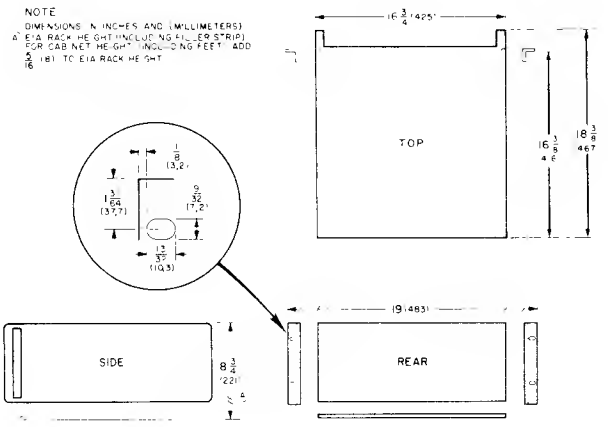
BEAM FINDER:

Pressing BEAM FINDER control brings trace on CRT screen, regardless of settings of horizontal or vertical position or intensity controls.

GENERAL:

Power Requirements: 115 or 230 volts ±10% ac, 50 to 60 Hz, normally less than 285 watts (varies with plug-in units used).

Dimensions:



Weight:
Without plug-ins, net 37 lbs (16, 7 kg); shipping, 45 lbs (21 kg).

SECTION I

GENERAL INFORMATION

1-1. DESCRIPTION.

1-2. The Model 140T, Figure 1-1, is a general purpose, plug-in type spectrum analyzer Display Section. The instrument has a fixed persistence, non-storage CRT with an internal graticule for parallax-free measurements. IF and RF Section spectrum analyzer plug-ins provide frequency domain analysis from 1 kHz to 1.2 GHz.

1-3. The instrument supplies power for the plug-ins and line-frequency square wave calibrating voltages of 10 volts and 1 volt peak-to-peak, available at the front panel. The primary power switch and all CRT controls are on the front panel; the terminals and switch for Z-axis modulation are on the rear panel.

1-4. The instrument also accepts all HP 1400-series time-domain plug-ins listed in Table 1-2 and in the Hewlett-Packard Instrumentation Catalog. Both plug-in compartments are the same size, and the plug-in instruments may be interchanged for any special application. The divider shield, which separates the two compartments, may be removed and one double sized plug-in installed. See Table 4-1 for power supply current limitations. Complete specifications for the instrument are given in Table 1-1.

1-5. CATHODE-RAY TUBE.

1-6. The instrument has an internal graticule CRT that eliminates parallax error when observing the display. The CRT is equipped with a nonglare safety face plate. A type P31 aluminized phosphor CRT is normally furnished with the instrument.

1-7. WARRANTY.

1-8. This instrument is certified and warranted as stated on the inside front cover of this manual. The CRT, however, is covered by a separate warranty located at the rear of the manual. Should the CRT fail within the time specified in the warranty, fill out the failure report form on the reverse side of the warranty statement and return with the CRT.

1-9. ASSOCIATED EQUIPMENT.

1-10. Some of the plug-ins available for this instrument are listed in Table 1-2. Normally, an RF Section is used in the upper compartment and an IF Section plug-in is used in the lower compartment. However, this instrument may also be used as an oscilloscope with a vertical plug-in in the upper compartment and time-base plug-in in the lower compartment. Refer to Section III for a

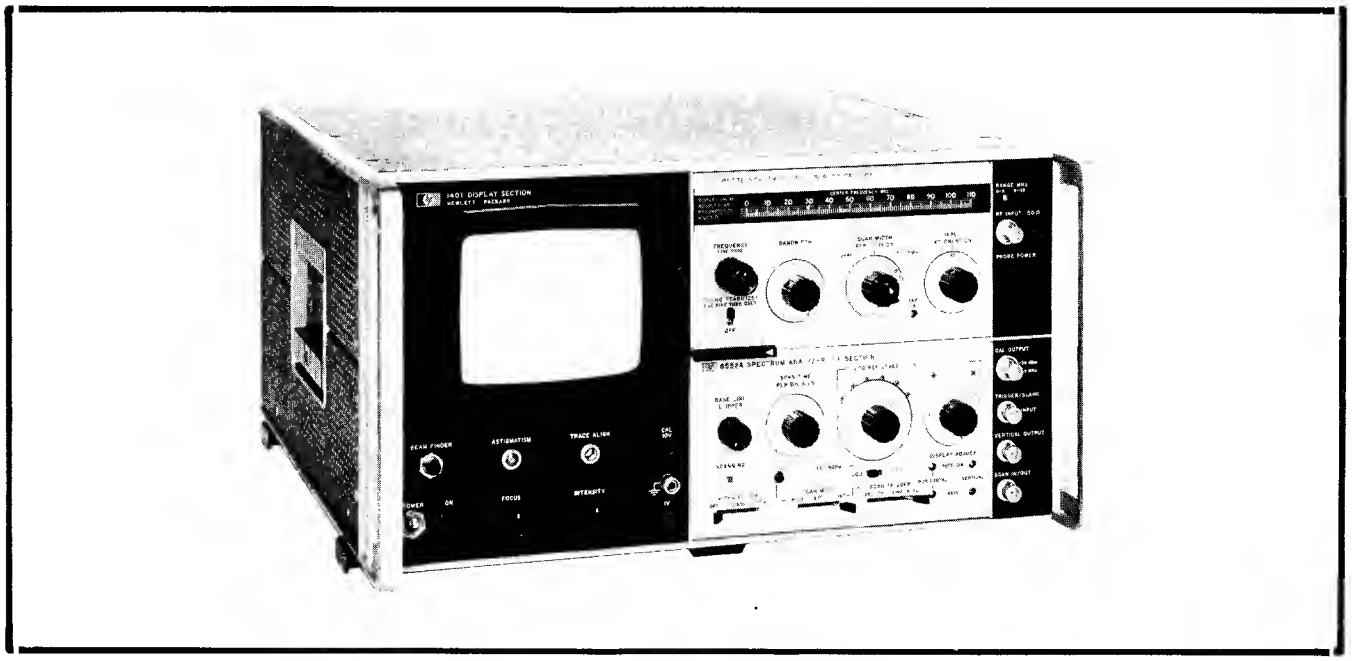


Figure 1-1. Model 140T Display Section with
Model 8552A/8553B Spectrum Analyzer Plug-ins

detailed explanation of applications and operating information.

1-11. MANUAL IDENTIFICATION.

1-12. This manual applies directly to Model 140T instruments with the serial prefix listed on the title page. The serial prefix is the first three digits of the eight digit serial number (000-00000) located on a plate at the rear of the instrument. For instruments with a serial prefix other than that given on the title page, refer to either an enclosed Manual Changes sheet or to Section VII for information necessary to make this manual correspond with the instrument.

1-13. Manual printing errors, called errata, are corrected on the enclosed Manual Changes sheet (if any). Refer any questions regarding the instrument, manual, or change sheet to the nearest HP Sales/Service Office listed at the rear of this manual. Be sure to identify the instrument by both model and eight-digit serial number in all correspondence.

1-14. SCOPE OF MANUAL.

1-15. This manual contains complete operating and service information for the instrument and is supplemented by the information presented in the Model 8500-series and Model 1400-series plug-in manuals. All aspects of the instrument are covered in eight sections, each of which can be easily referred to by use of the table of contents. Schematic diagrams are located in Section VIII on fold-out pages to permit reference to the text, and an overall block diagram is in Section IV.

Table 1-2. Plug-ins for Model 140T Display Section.

FUNCTION	HP MODEL NUMBER	CAPABILITIES												
		Wide Band	Sampling	High Gain Differential	Dual Trace	Four Trace	X-Y	Delayed Sweep	No Drift	High CMR	Algebraic Addition	TDR*	Wide Band TDR	Swept Frequency
VERTICAL PLUG-INS	1400A			x			x							
	1400B			x			x			x				
	1401A				x		x				x			
	1402A	x			x		x				x			
	1403A			x			x			x	x			
	1404A	x				x	x				x			
	1405A	x			x		x				x			
	1406A			x			x		x	x				
	1407A			x			x		x	x				
	1408A			x	x		x			x	x			
	1410A		x		x		x				x			
	1411A		x		x		x				x		x	
	1430A		x										x	
	1431A		x											
	1432A		x											
COMPATIBLE TIME BASES	1420A	x		x	x				x	x	x			
	1421A	x		x	x			x	x	x	x			
	1422A			x	x			x	x	x	x			
	1423A	x		x	x				x	x	x			
	1424A		x		x						x		x	
	1425A		x		x			x			x		x	
DOUBLE SIZE PLUG-INS	1415A											x		
	1416A													x
BLANK PLUG-INS	10477A	Single-size for special purpose circuit.												
	10478A	Double-size for special purpose circuit.												
SPECTRUM ANALYZER	8552A/ 8553B or 8554L	Fixed or variable scan spectrum analysis.												

* Time Domain Reflectometry.

SECTION II

INSTALLATION

2-1. INITIAL INSPECTION.

2-2. VISUAL CHECK. Inspect the instrument upon arrival for shipping damage. Check for external damage such as broken or bent parts, dents or scratches. If damage is found, refer to the CLAIMS paragraph in this section for the recommended claims procedure.

2-3. ELECTRICAL CHECK. Check the electrical performance of the instrument as soon as possible after receipt. Section V, Performance Checks, will verify instrument operation within the specifications listed in Table 1-1. Initial performance and accuracy of the instrument are certified as stated on the inside front cover of this manual. If the instrument does not operate as specified, refer to the following recommended claim procedure.

2-4. CLAIMS.

2-5. The warranty statement applicable to all Hewlett-Packard Company instruments and products is provided inside the front cover of this manual. If physical damage is found or if operation is not as specified when the instrument is first received, notify the carrier and the nearest Hewlett-Packard Sales/Service Office immediately. The Sales/Service Office will arrange for repair or replacement of the instrument without waiting for settlement of a claim with the carrier. For other than initial inspection warranty claims, contact the Sales/Service Office.

2-6. REPACKING FOR SHIPMENT.

2-7. When shipping an instrument to a Hewlett-Packard Sales/Service Office, attach a tag describing required service, and include model number, eight digit serial number, and return address.

2-8. Use the original shipping carton and packaging materials for reshipment. If the original material is neither available or reuseable, use the following:

a. A double walled carton (see Table 2-1 for test strength required).

b. Heavy paper or sheets of cardboard to protect all instrument surfaces (use a nonabrasive material such as polyurethane or a cushioned paper such as Kimpak around all projecting parts).

c. At least 4 inches of industry approved, tightly packed shock absorbing material, such as extra firm polyurethane foam.

d. Heavy duty shipping tape to secure outside of carton.

Table 2-1. Shipping Carton Test Strength

Gross Weight (lbs)	Carton Test Strength (lbs)
up to 10	200
10 to 30	275
30 to 120	350
120 to 140	500
140 to 160	600

2-9. PREPARATION FOR USE.

2-10. POWER REQUIREMENTS.

2-11. The instrument requires a power source of either 115 or 230 volts ac, ±10%, single phase, 50 to 60 Hz which can deliver approximately 300 watts. A rear panel switch provides selection of the line voltage to be used.

CAUTION

Be sure to set the rear panel switch for the line voltage to be used. The power supplies may be damaged if the switch is set to the wrong position.

2-12. 230-VOLT OPERATION.

2-13. If the instrument is to be operated from a 230-volt source, set the rear panel switch to 230. The line fuse, F1, is accessible by removing the bottom cover of the instrument. Remove the 4-amp slow-blow fuse, and install a 2-amp slow-blow fuse.

2-14. THREE-CONDUCTOR POWER CABLE.

2-15. For the protection of operating personnel, the National Electrical Manufacturers' Association (NEMA) recommends that the instrument panel and cabinet be grounded. The instrument is equipped with a detachable, three-conductor power cable which, when plugged into an appropriate receptacle, grounds the instrument. The offset (round) pin on the power cable connector is the ground pin. To preserve the protection feature when operating the instrument from a two-contact outlet, use a three-conductor to two-conductor adapter and connect the green lead on the adapter to ground at the power outlet.

2-16. INSTRUMENT COOLING.

2-17. The instrument uses a forced-air cooling system to maintain reasonable operating temperatures within the instrument. Warm air is exhausted through the side panel perforations. When operating the instrument, choose a location which provides at least three inches of clearance around the rear and both sides.

2-18. The cooling fan and air filter require periodic lubrication and cleaning. Refer to Section VIII for maintenance instructions.

2-19. INSTRUMENT MOUNTING.

2-20. MODULAR CABINET. The instrument is shipped from the factory as a bench instrument with the tilt stand, feet, and plastic trim in place. The top and bottom panel covers can be removed, giving complete accessibility to all components and adjustments. Sufficient space should be left around the sides of the cabinet to allow unrestricted air circulation.

2-21. RACK MOUNTING. A kit for converting the modular cabinet to a rack mount is supplied with each instrument. Instructions for making the conversion are given below. Refer to Figure 2-1 as an aid to identifying parts.

a. Detach tilt stand by pressing away from front feet; remove all plastic feet by pressing metal button and sliding foot free.

b. Aluminum trim strips (behind each front handle) on sides of instrument have an adhesive back; use a thin-blade tool to remove them.

c. Attach a rack-mounting flange, using screws provided in kit, in each space where trim strip was adhered; larger notch of flange should be positioned at instrument bottom.

d. If the instrument is to be placed in a rack above or below another HP instrument, attach filler strip provided with kit between front panels of instruments.

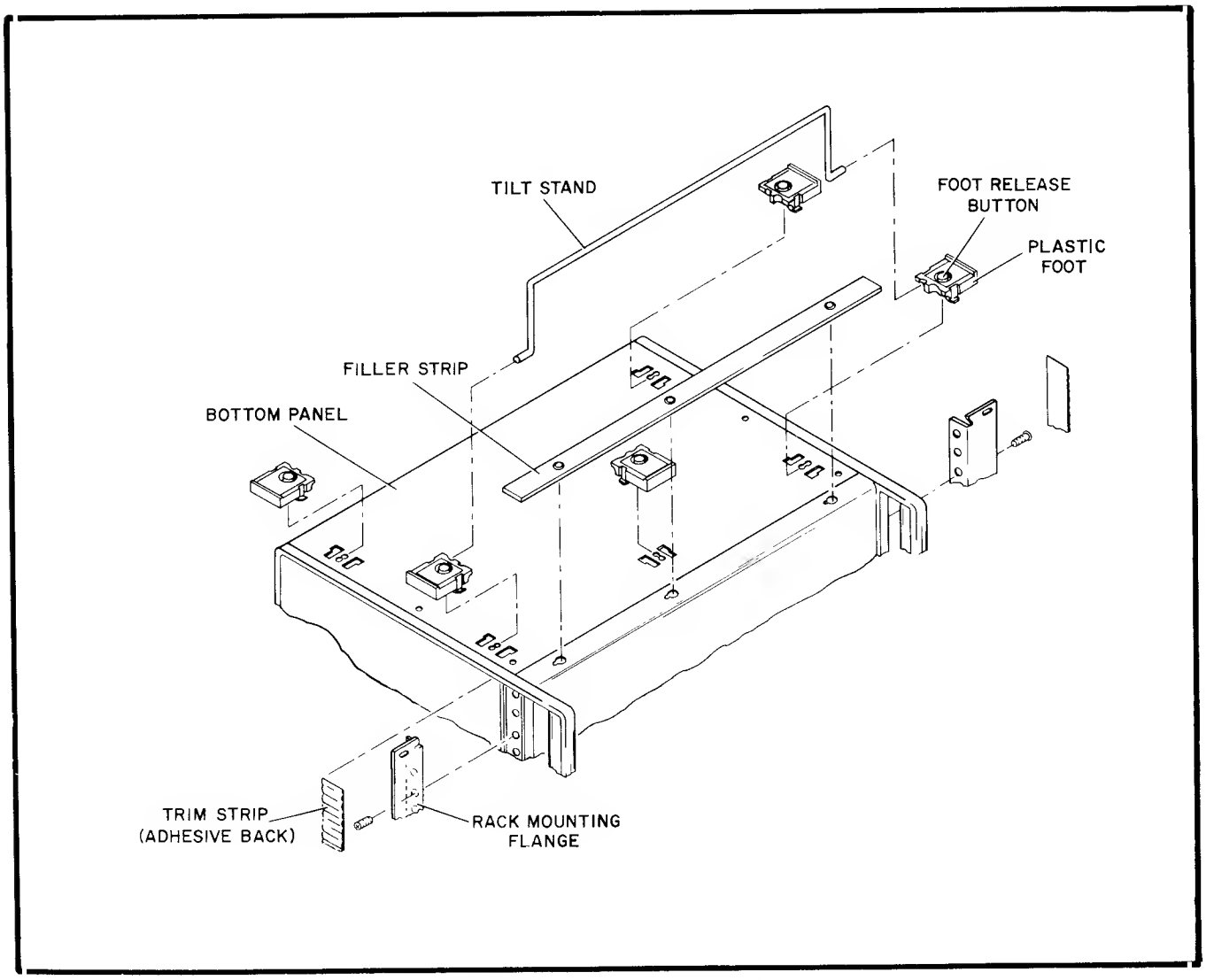


Figure 2-1. Rack Mounting Procedure.

SECTION III

OPERATION

3-1. INTRODUCTION.

3-2. Front-panel control information and operating instructions are contained in this section. Since a variety of different plug-in combinations can be used with the Model 140T, operating information for only this instrument is given. If necessary, refer to the specific plug-in manual for supplementary data.

3-3. FRONT PANEL COMPONENTS.

3-4. Figure 3-1 identifies the front panel controls and gives a brief functional description of each. Additional information on some of the controls is given below.

3-5. BEAM FINDER. A very high dc input signal may drive the trace off the CRT screen. When the BEAM FINDER is pressed, the trace will be returned to the screen regardless of the setting of horizontal or vertical POSITION controls. If pressing the BEAM FINDER pushbutton does not return a visible beam to the viewing area, hold the BEAM FINDER depressed and gradually adjust the INTENSITY control to obtain a visible trace. To prevent phosphor damage, instruments supplied with a P11 phosphor CRT do not intensify the beam when BEAM FINDER is pressed.

CAUTION

BEAM FINDER should be pressed only momentarily and then released. If it is held pressed, damage to the CRT may occur.

3-6. TRACE ALIGN ADJUSTMENT. To compensate for slight manufacturing tolerances and external magnetic disturbances, a front panel screwdriver adjustment is provided to align the trace parallel with the graticule. Check trace alignment after moving the instrument to a new operating location.

3-7. ASTIGMATISM ADJUSTMENT. To provide uniform focus of the trace over the display area, the ASTIGMATISM control, a front panel screwdriver adjustment, is used in conjunction with the FOCUS control. For correct adjustment, adjust both FOCUS and ASTIGMATISM for sharpest display of signal. Because different plug-in units apply different DC potentials to the deflection plates, it is usually necessary to readjust ASTIGMATISM whenever plug-ins are changed.

3-8. CALIBRATOR. Two power line frequency, square wave signals are available at the front panel CALIBRATOR jacks. These signals have 1% accurate amplitudes of 1V and 10V pk-pk and are useful, for example, when checking the sensitivity of a Model 1400-series vertical plug-in.

CAUTION

To prevent over-drive damage to spectrum analyzer plug-ins, do not apply CALIBRATOR signals.

3-9. REAR PANEL COMPONENTS.

3-10. 115/230 VOLT SWITCH. This switch, located at the bottom of the rear panel, must be set to the position which corresponds to the line voltage to be used. The instrument is shipped with a 4-amp fuse installed for 115-volt operation. If the instrument is to be connected to a 230-volt outlet, change the fuse to a 2-amp, slow-blow fuse (supplied with the instrument).

3-11. Z-AXIS INPUT, When the instrument is used with Spectrum Analyzer plug-ins, the Z-Axis terminals and selector switch on the rear panel are inoperative.

3-12. To modulate the trace intensity externally in conventional oscilloscope applications, set the switch to EXT, remove the shorting strap and connect the modulation signal to the terminals. The amplitude of the pulse required to blank the trace depends on the front panel INTENSITY control setting, and is approximately 20 volts positive for normal intensity settings. If desired, a negative pulse can be used to intensify the trace. When not using external intensity modulation, connect the strap across the terminals and set the switch to INT.

3-13. PLUG-IN UNITS.

3-14. Currently available plug-ins for the Model 140T are listed in Table 1-2. This instrument is normally operated with an RF Section plug-in in the upper compartment and IF Section plug-in in the lower compartment. The Operating and Service Manuals for these units contain detailed information for installing plug-ins.

3-15. The Model 140T also accepts Model 1400-series plug-ins for standard oscilloscope use. No modifications are necessary since all circuit changes are designed into the plug-in units.

CAUTION

Do not operate instrument above 45°C, when using real time plug-ins.

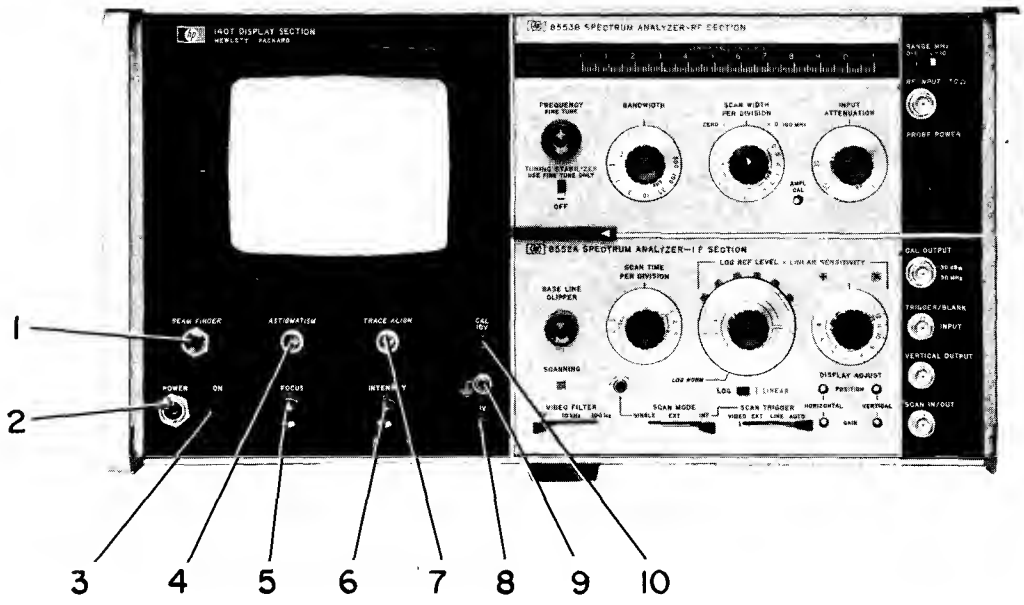
3-16. Arrangement of plug-ins can be selected to suit special applications. For example, a vertical amplifier and time base plug-in can be reversed so that sweep is vertical and signal deflection is horizontal. Or, a vertical plug-in can be used in each compartment to take X-Y measurements.

3-17. Double-sized plug-ins, such as the Model 1415A or 1416A, can be inserted into the instrument after removal of the divider shield between lower and upper compartments. Blank plug-ins, both single and double size, are available for customer fabrication of specialized vertical amplifier and time base plug-ins. Refer to Table 4-1 for power supply current limitations.

NOTE

For proper operation, the divider shield must be in place when using standard size plug-ins.

3-18. Due to slight differences in CRT sensitivities, it may be necessary to readjust the sensitivity calibration of plug-ins installed in the instrument for the first time, or when moved from one display section mainframe to another. Refer to the plug-in's Operating and Service Manual for the required adjustment procedure.



1. BEAM FINDER: Returns beam to CRT screen.
2. POWER: Applies AC line power to the instrument.
3. POWER: Indicates that the instrument is on.
4. ASTIGMATISM: Controls roundness of spot.
5. FOCUS: Adjusts focus of trace.
6. INTENSITY: Controls intensity of CRT display.
7. TRACE ALIGN: Aligns trace with graticule.
8. CAL 1V: 1-volt peak-to-peak calibrating signal (line frequency square wave).
9. GROUND: Provides reference for calibrating signal.
10. CAL 10 V: 10-volt peak-to-peak calibrating signal (line frequency square wave).

Figure 3-1. Model 140T Controls

SECTION IV

PRINCIPLES OF OPERATION

4-1. OVERALL FUNCTIONAL DESCRIPTION.

4-2. Refer to the Block Diagram, Figure 4-1, for this explanation. The Model 140T Display Section has three main circuits: a low-voltage supply, a high-voltage supply, and a calibrator circuit. The horizontal and vertical amplifier circuits are in the plug-in units and operate directly into the CRT.

4-3. LOW VOLTAGE SUPPLY. The low voltage supply uses 115 or 230 volts ac (rear panel switch), single phase, 50 - 60 Hz. Output voltages are -12.6, -100, +100, and +250 volts dc; all outputs are fused and are electronically regulated. Voltages are distributed to the high voltage supply, the calibrator circuit, and to the horizontal and vertical plug-ins. 6.3 Vac is supplied from the low voltage transformer to the filament of the CRT and as a signal to the calibrator.

4-4. CALIBRATOR. The 6.3Vac applied to the calibrator circuit is shaped into a line frequency square wave and applied to two front panel connectors, 10 V and 1 V (peak-to-peak amplitude). The 1 volt output is also applied internally to the vertical and horizontal plug-ins for sensitivity calibration. Accuracy of the calibrating signal is ±1%.

4-5. HIGH VOLTAGE SUPPLY. A transistorized oscillator and a step-up transformer are used to generate negative and positive high voltages for the CRT. Both the +5000 volt and -2350-volt supplies are electronically regulated.

4-6. CIRCUIT DESCRIPTION.

4-7. LOW-VOLTAGE SUPPLY.

4-8. The low-voltage supply consists of: +100 volt supply, -100 volt supply, +250 volt supply and -12.6 volt supply. The +100 volt supply is independent, and provides a reference voltage for the -100 volt supply. The +250 volt and -12.6 volt supplies are referenced to the +100 and -100 volt supplies.

4-9. Figure 4-2 is a simplified block diagram of a regulator used in the low voltage supply. The series regulator acts as a variable resistance in the regulated output. A sensor (or differential amplifier) compares the output voltage to a

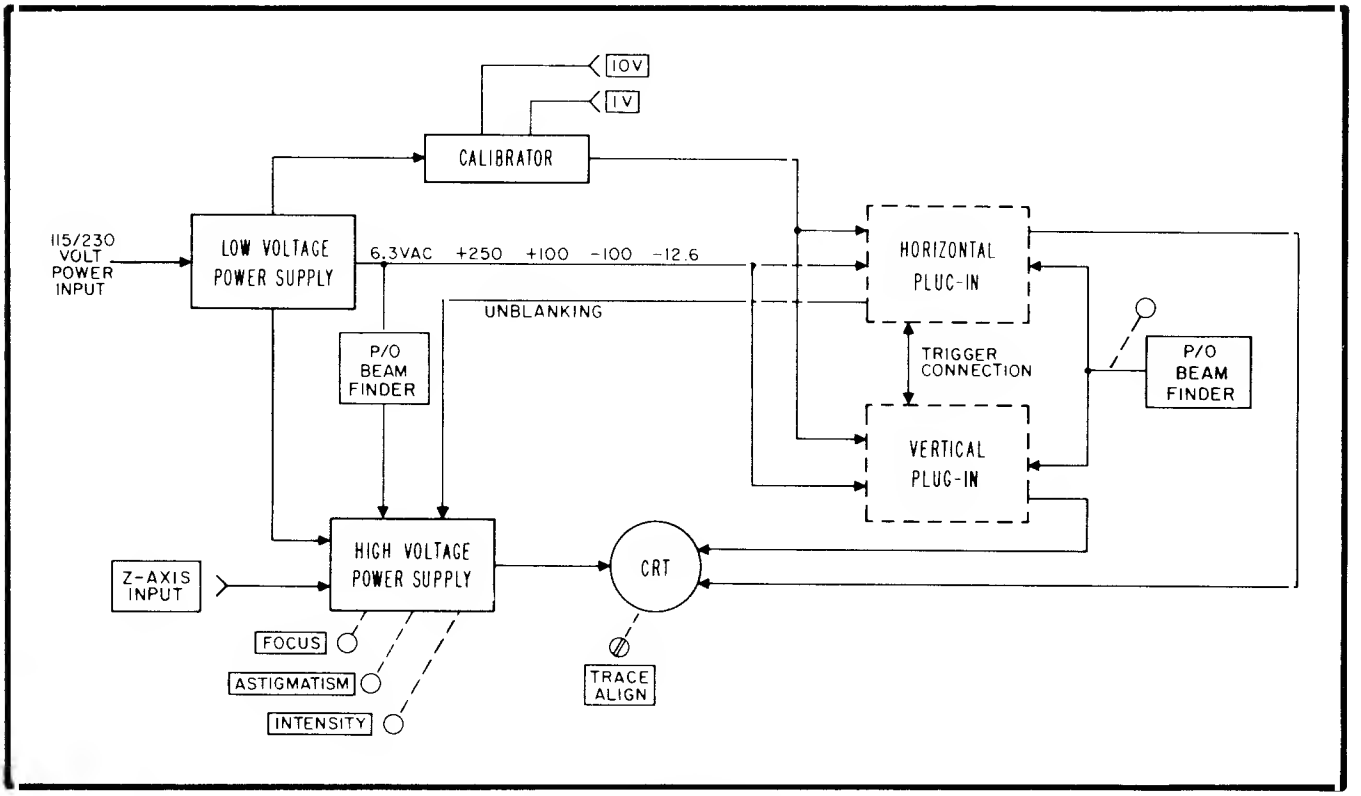


Figure 4-1. Model 140T Block Diagram

reference voltage (dc return for the supply). The driver (emitter follower or amplifier) controls the bias on the series regulator, which effectively controls the series resistance. Any change in output voltage is fed back to the series regulator. The change in series resistance and the resulting voltage drop is opposite to the output voltage change and maintains the output voltage at a constant level.

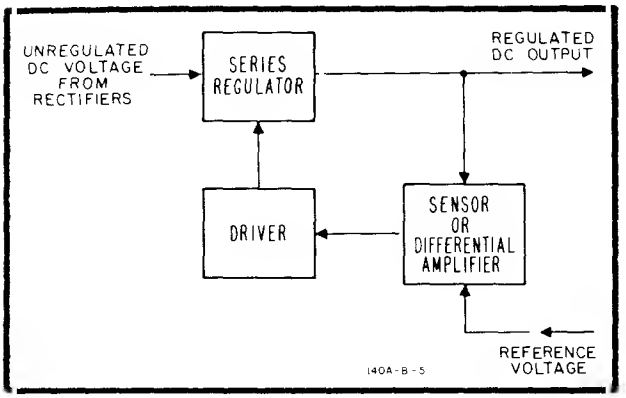


Figure 4-2. Regulated Power Supply Block Diagram

4-10. Figure 8-5 is a schematic diagram of the low voltage supply. The primary winding of transformer T401 is wired through a rear panel switch for conversion to either 115 or 230 Vac operation. Line voltage is applied to the primary of T401 through an on-off switch, a fuse, and a thermal switch. A pilot lamp indicates when power is applied to T401.

4-11. + 100 VOLT SUPPLY. The ac voltage from the secondary of T401 is rectified by CR441-CR444 and partially filtered by C441 and R441. The resulting dc voltage is applied through the Series Regulator,Q441, to the output. Differential Amplifier Q443/Q444 compares the voltage across V441 with a sample of the output voltage. Any output voltage change is applied to the base of the Driver, Q442, which controls the bias of Series Regulator, Q441. Series Regulator, Q441, compensates for the change in output voltage by the change in series resistance and restores the output level to normal. The +100 volt output is adjusted by R453. Fuse F441 provides overload protection.

4-12. -100 VOLT SUPPLY. Reference voltage for the -100 volt supply is taken from the output of the +100 volt supply. The reference voltage across R467 and R473 is compared with a sample of -100 volt output across R471. The error voltage sensed by Differential Amplifier, Q463/Q464, is applied through the Driver, Q462, and Series Regulator, Q461. The Series Regulator brings the -100 volt supply back into proper balance with respect to the +100 volt supply. AC voltage from T401 is rectified by CR461-CR464, partially filtered by C461/C462/R461, and the resulting dc voltage is applied by the Series Regulator, Q461, to the -100 volt output. Regulation is obtained as in the +100 volt supply. R471 adjusts the -100 volt output and fuse F461 provides overload protection.

4-13. +250 VOLT SUPPLY. Sensor Amplifier, Q423, in the +250 volt supply senses any variation in the output voltage, with respect to -100 volts. The error voltage is amplified by Driver, Q422, which applies corrective bias to Series Regulator, Q421. R432 adjusts the +250 volt output and fuse F421 provides overload protection. CR427 provides temperature compensation for Q423 and is normally forward-biased. Two shunt resistors are connected to the +250 volt supply to reduce series regulator power dissipation when high-current plug-ins are used. The shunts are wired one to each rear panel plug and the internal wiring of the plug-in determines if the shunt is used.

4-14. -12.6 VOLT SUPPLY. Sensor Amplifier Q484, senses any variation of output voltage with respect to -100 volts and applies the error voltage to Driver Amplifier, Q482. The Driver increases signal current to the level required to control Series Regulator, Q481. The -12.6 volt output is adjusted by R488. Current Limiter, Q483, a protective circuit for the Series Regulator, is normally biased off. If an overload occurs across the -12.6 volt output, the base of Q483 goes positive by the voltage drop across R483 minus the forward voltage drop across CR483, and turns Q483 on. The decreased positive voltage on the collector of Q483 is applied through Q482 to the base of Series Regulator, Q481, reducing the current flowing through Q481. The current which then flows through the overload is limited to the current required to keep Q483 on. Additional overload protection is provided by fuse, F481.

4-15. CALIBRATOR.

4-16. The schematic diagram of the Calibrator circuit is shown in Figure 8-5. The circuit consists of three parts: a tunnel diode square wave generator, a transistor switch and a calibration network.

4-17. 6.3 volts ac is applied through R491 to tunnel diode CR490, which generates a square wave at line frequency. Transistor switch Q490 is off during the time of the positive half cycle of the square wave (when the voltage at the base is close to zero), and the collector voltage is at a level set by voltage divider R493, R495, and R496. When the negative-going portion of the square wave is applied to the base of Q490, the transistor conducts heavily, effectively shorting the collector to ground and calibrator output is zero volts. At the end of the negative input half cycle, the bias of Q490 returns to zero, the transistor is switched off, and the output returns to its previous value.

4-18. Tunnel diode bias current is supplied through R492. The bias current sets an operating level for the diode which affects the symmetry of the square wave output. Cal Adj, R494, is used to set the dc voltage at the collector of Q490 to -10 volts when the transistor is off. Breakdown diode CR491 reduces the output impedance, and provides temperature compensation for the circuit. Voltage divider R495/R496 reduces the 10 volt output to 1 volt. Both 10 and 1 volt outputs are available on the front panel and the 1 volt output is wired to both plug-in jacks.

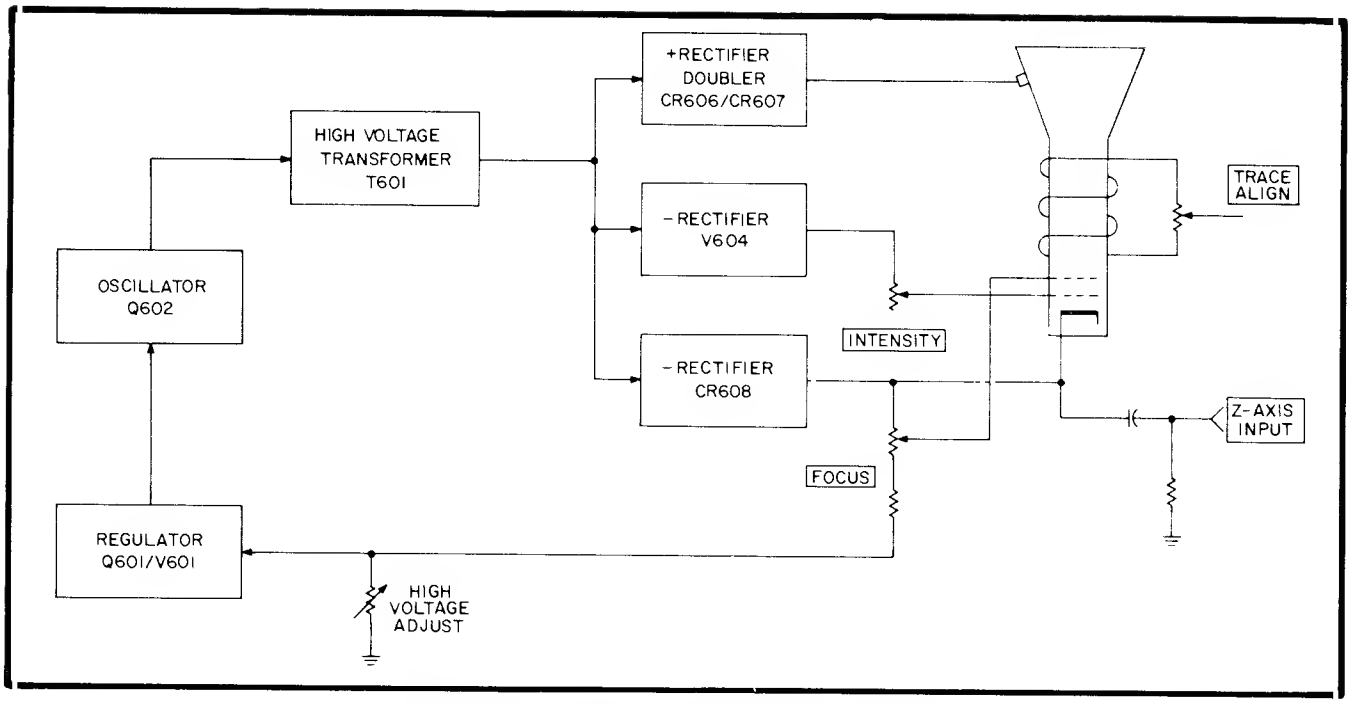


Figure 4-3. High-Voltage Power Supply Block Diagram

4-19. HIGH-VOLTAGE SUPPLY.

4-20. Figure 4-3 is a block diagram of the high voltage supply. The output of a regulated transistor oscillator is stepped up in voltage and applied to a series of high voltage rectifiers. The positive output of the voltage doubler is connected to the CRT post-accelerator. The negative output voltages are used in the gun assembly of the CRT and the associated controls. The Z-axis input can be used to apply intensity modulating signals to the CRT.

4-21.. Figure 8-9 is a schematic diagram of the high voltage supply and the CRT. Oscillator Q602 operates at a frequency of approximately 32 kHz. Any change in the output voltage is applied to the grid of V601, which converts the voltage change to a current change. This current change is applied by Emitter Follower, Q601, to the base of the oscillator transistor. The amplitude of oscillations is changed in a direction to oppose the original output voltage change. High Voltage Adjust, R619, sets the amplitude of oscillation to produce the correct output voltage.

4-22. Two separate negative supplies are used, one for the CRT control grid, and one to provide CRT cathode and focusing voltages. Both supplies use half wave rectifiers (V604 and CR608). The focusing voltage is derived from a resistive voltage divider connected to the -2350 V cathode supply. The unblanking gate from the horizontal plug-in (pin 1, J2) is applied to the return side of the grid supply, and changes the negative grid voltage by about +50 volts to unblank the trace. A positive pulse of about 20 volts will blank the trace when applied to Z-axis input. When Z-axis input is not used, set S601 to INT to receive chopped blanking from a dual-trace plug-in.

4-23. The Rectifier Doubler circuit, CR606/CR607, provides the 5-kV CRT post-accelerating voltage.

4-24. The ASTIGMATISM adjustment, R641, adjusts the roundness of the spot, and the Geometry adjustment, R643, is used to adjust pattern shape.

4-25. TRACE ALIGN.

4-26. The Trace Align coil, L602, is located around the CRT neck near the screen. Adjustment of Trace Align, R650A/B, changes the magnitude and direction of current through the coil, rotates the trace, and aligns it with the CRT graticule.

4-27. PLUG-IN KIT FABRICATION.

4-28. The HP Model 10477A and Model 10478A Accessory Plug-ins are blank plug-in units for the instrument. These two units permit the user to design his own special-purpose circuits. Current available from each power supply is listed in Table 4-1. Circuit power requirements should not exceed the capabilities in the table.

Table 4-1. Current Capability

Supply Voltage and J1/J2 pin number		Current Available At Each Jack (J1 and J2)
+250 vdc	9	0-50 ma
+250 vdc	9	50-100 ma (pin 2 must be wired to pin 3 in the plug-in.)
+100 vdc	2	137.5 ma
-100 vdc	6	10-200 ma
-12.6 vdc	21	0-0.9 amp
6.3 vac	13-14	0-3.25 amp

Table 5-1. Recommended Test Equipment

Recommended Instrument	Model	Required For	Ref. Para	Required Characteristics
Voltmeter Calibrator	HP 738AR or 738BR	Calibrator Check; Calibrator Adjustment; High Voltage Adjustment	5-16 5-33 5-24	1V and 10V pk-pk; outputs -300Vdc; ±2%
DC Voltmeter	HP 412A	Low Voltage Adjustment	5-22	-100V to +250V, ±1%
DC VTVM	HP 410 B/C	High Voltage Adjustment	5-24	May be adapted for high voltage (-2.5 kV) measurement. Provision for altering calibration.
Voltage Divider	HP 1104A	High Voltage Adjustment	5-24	Provide 100:1 division for high voltage measurement.
Oscillator	HP 200CD	Geometry Adjustment	5-30	20 kHz ±2%, 600 ohms output impedance
VHF Generator	HP 608D/ E/F	Geometry Adjustment	5-30	30 MHz, -35 dBm sinewave

SECTION V

PERFORMANCE CHECK AND ADJUSTMENTS

5-1. INTRODUCTION.

5-2. Instrument performance check and adjustment procedures are contained in this section. The purpose of this information is to indicate whether or not instrument operation is within the specifications of Table 1-1. Troubleshooting information, schematic diagrams and component locations are in Section VIII.

5-3. TEST EQUIPMENT.

5-4. Test equipment recommended for the performance check, adjustments, and to maintain the instrument are listed in Table 5-1. Equivalent test equipment can be substituted, if necessary. For proper results, make sure that all test equipment have recently been calibrated. Use a non-metallic screwdriver for making adjustments.

5-5. PERFORMANCE CHECK.

5-6. It is preferable to do the performance check in the given sequence since succeeding steps depend on the control settings and results of earlier steps. However, steps may be done individually or out of sequence by referring to the preliminary control settings and the steps prior to the desired one.

5-7. Enter the results of the initial performance check on the Performance Check Record at the end of the procedure. Then remove the form from the manual and file it for future reference (be sure to include the instrument serial number for identification).

5-8. PRELIMINARY SET-UP.

5-9. This procedure can be followed using either spectrum analyzer or oscilloscope plug-ins. Install an RF Section plug-in in the upper compartment and an IF Section plug-in in the lower compartment. Or, install a time base plug-in in the upper compartment and a vertical plug-in in the lower compartment. Since operation of this instrument is dependent on the performance of the plug-ins, make certain that these instruments have been recently calibrated before proceeding.

5-10. INITIAL CONTROL SETTINGS.

a. Instrument Display Section:

TRACE ALIGN ..... mid-range
ASTIGMATISM ..... mid-range
FOCUS ..... mid-range
INTENSITY ..... ccw
INT/EXT (rear panel) ..... INT

b. Spectrum analyzer plug-ins:

Tuning Stabilizer ..... on
Bandwidth ..... 300 kHz
Scan Width Per Division ..... zero
Input Attenuation ..... 0 dB
Baseline Clipper ..... ccw
Scan Time Per Division ..... 0.1 msec
Log Ref Level/Linear Sensitivity ..... ccw
Log/Linear ..... log
Video Filter ..... off
Scan Mode ..... Internal
Scan Trigger ..... auto

c. Vertical plug-in (if used):

Input ..... on
Coupling ..... ac
Position ..... mid-range

d. Time Base plug-in (if used):

Position ..... mid-range
Trigger Source ..... internal
Trigger Slope ..... positive
Level ..... free-run or auto
Sweep Mode ..... normal
Time/Div ..... 1 msec

e. Apply power and allow a fifteen minute warm-up.

5-11. BEAM FINDER.

5-12. When spectrum analyzer plug-ins are used, pressing the BEAM FINDER will intensify the trace but will not bring an offset trace back to the viewing area. Do the following if using oscilloscope plug-ins.

a. Adjust INTENSITY for a visible trace.

NOTE

If the horizontal plug-in is not a time base type, connect the CALIBRATOR signal to the horizontal amplifier input to obtain a straight line trace.

b. Remove trace from screen by rotating the vertical and horizontal position controls.

c. Set INTENSITY fully counterclockwise.

d. Press the BEAM FINDER pushbutton.

e. The trace should return to the screen.

5-13. **INTENSITY.**

a. Readjust INTENSITY and the position controls to return the trace on screen.

b. Rotate the INTENSITY control.

c. Note that the trace intensity varies smoothly from extinguished to brighter than normal.

5-14. **FOCUS AND ASTIGMATISM.**

a. Adjust INTENSITY for just a visible trace.

b. Rotate the FOCUS and ASTIGMATISM controls.

c. Note that each control focuses the display at approximately mid-range.

NOTE

It may be necessary to slightly readjust FOCUS and ASTIGMATISM whenever the intensity level is changed.

5-15. **TRACE ALIGN.**

a. Using the position controls, set the trace on the horizontal axis.

b. Adjust TRACE ALIGN so that the trace is parallel to the horizontal axis.

5-16. **CALIBRATOR.**

5-17. Do the following check only if using oscilloscope plug-ins.

CAUTION

Do not connect the instrument CALIBRATOR signal to the spectrum analyzer plug-ins or damage may result.

a. Set Volts/Div to 0.2.

b. Connect a 60 Hz, 1V pk-pk signal from the Voltmeter Calibrator to the vertical input.

c. Adjust Time/Div to obtain a satisfactory display, and adjust vertical amplifier sensitivity calibration for 5 vertical divisions.

d. Disconnect the Voltmeter Calibrator, and connect the 1V CALIBRATOR signal from the instrument front panel to the vertical input.

e. Note a display of 5 vertical divisions ±0.25 minor divisions.

f. Remove the 1V CALIBRATOR signal, and set Volts/Div to 2.

g. Connect a 60 Hz, 10V pk-pk signal from the Voltmeter Calibrator to the vertical input.

h. Adjust vertical amplifier sensitivity calibration for 5 vertical divisions of display.

i. Disconnect the Voltmeter Calibrator, and connect the 10V CALIBRATOR signal from the instrument front panel to the vertical input.

j. Note a display of 5 vertical divisions ±0.25 minor divisions.

k. Disconnect the CALIBRATOR signal.

5-18. ADJUSTMENTS.

5-19. Physical location of all internal adjustments is shown in Figure 5-2, and recommended test equipment is listed in Table 5-1. After adjustments are completed, check operation by doing the performance check in the previous paragraphs.

5-20. **PRELIMINARY SET-UP.**

5-21. This procedure can be followed using either spectrum analyzer or oscilloscope plug-ins. Install an RF Section plug-in in the upper compartment and an IF Section plug-in in the lower compartment. Or, install a time base plug-in in the upper compartment and a vertical plug-in in the lower compartment. This instrument must be properly loaded during the adjustment procedure to ensure correct power regulation.

a. Remove the top, bottom and side covers.

b. Apply power and allow a fifteen minute warm-up.

c. Set the plug-in controls to obtain a trace.

d. Adjust INTENSITY and the position controls for a mid-screen trace of normal intensity.

e. Adjust FOCUS, ASTIGMATISM and the plug-in controls for a sharply focused trace.

5-22. **LOW-VOLTAGE POWER SUPPLIES.**

5-23. With the DC Voltmeter, monitor each low voltage supply output to ground. Make the appropriate adjustment according to Table 5-2, following the given sequence. Measurements may be taken from any wire bearing the indicated color code.

5-24. **HIGH-VOLTAGE POWER SUPPLY.**

5-25. The VTVM, Voltmeter Calibrator and 100:1 Voltage Divider are required for this check.

PERFORMANCE CHECK RECORD

Serial Number: _____

Paragraph	Check	Min.	Reading	Max.
5-12 step e	BEAM FINDER	trace visible	_____	
5-13 step c	INTENSITY	extinguished	_____	brighter than normal
5-14	FOCUS AND ASTIGMATISM			
step c	focus	focuses at midrange	_____	
step c	astigmatism	focuses at midrange	_____	
5-15 step b	TRACE ALIGN	horizontal trace	_____	
5-17	CLAIBRATOR			
step e	1V CAL signal	4 div +0.75 minor div.	_____	5 div +0.25 minor div.
step j	10V CAL signal	4 div + 0.75 minor div.	_____	5 div + 0.25 minor div.

Table 5-2. Low-voltage Power Supply Adjustments

Supply Voltage	Wire Color Code	Adjustments
+100V	White/Red (92)	R453
-100V	Violet (7)	R471
-12.6V	White/Violet (97)	R488
+250V	Red(2)	R432

WARNING

Voltages present in the high-voltage power supply are dangerous to life.

a. Connect the 100:1 Voltage Divider to the VTVM dc probe.

b. Set VTVM to -3 Vdc range.

c. Set Voltmeter Calibrator output to -300 Vdc, and touch with divider tip.

d. Adjust the VTVM gain to provide a reading of -3 Vdc.

e. Set the VTVM to the -30 Vdc range, and measure the voltage at the junction of R651 and R652.

f. Adjust R619 for -23.5 Vdc indication on the VTVM.

g. Disconnect the VTVM and remove the Voltage Divider.

5-26. INTENSITY LIMIT.

5-27. No test equipment is required for this adjustment.

CAUTION

Keep the beam intensity low to prevent the CRT phosphor from being damaged.

a. Set the INTENSITY control to the 10 o'clock position.

b. Adjust R612 to just extinguish a focused spot.

5-28. ASTIGMATISM.

5-29. No test equipment is required for this adjustment.

a. Position a low intensity spot at mid-screen.

b. Adjust FOCUS and ASTIGMATISM for a small, round, sharply-focused spot.

5-30. GEOMETRY.

5-31. To do this adjustment using spectrum analyzer plug-ins, proceed as follows:

a. Spectrum analyzer control settings:

Frequency ..... 30 MHz
Fine Tune ..... mid-range
Tuning Stabilizer ..... on
Bandwidth ..... 300 kHz
Scan Width Per Division ..... zero
Input Attenuation ..... 0 dB
Baseline Clipper ..... ccw
Scan Time Per Division ..... 1 msec
Log Ref Level/Linear Sensitivity ..... 1 mV/div
Log/linear ..... linear
Video Filter ..... off
Scan Mode ..... internal
Position ..... centered
Gain ..... calibrated

CAUTION

Adjust the following test equipment as described below before connecting to this instrument.

b. Adjust the VHF Generator to produce a 30 MHz, -35 dBm sinewave.

c. Externally modulate the VHF Generator with a 20 kHz, 6V peak-to-peak sinewave signal from the oscillator.

d. Adjust the VHF Generator for 95% modulation.

e. Using a BNC-to-BNC coaxial cable, connect the output of the VHF Generator to the RF Input jack on the RF Section plug-in.

f. Readjust the Frequency control on the RF Section plug-in for maximum vertical display.

g. Readjust the Linear Sensitivity control on the IF Section plug-in for an eight-division vertical display. Use the position controls as necessary.

h. Check the displayed pattern for excessive pincushioning or barreling as shown in Figure 5-1. If either effect is present, adjust R643 to obtain a rectangular pattern with straight vertical and horizontal edges.

5-32. To do this adjustment using oscilloscope plug-ins, do the following:

a. Center a trace on the CRT.

b. Connect the Oscillator output to the vertical plug-in.

c. Adjust the Oscillator amplitude and frequency to obtain an 8-div by 10-div pattern on the screen.

d. Check the displayed pattern for excessive pincushioning or barreling as shown in Figure 5-1. If either effect is present, adjust R643 to obtain a rectangular pattern with straight vertical and horizontal edges.

e. Disconnect the Oscillator.

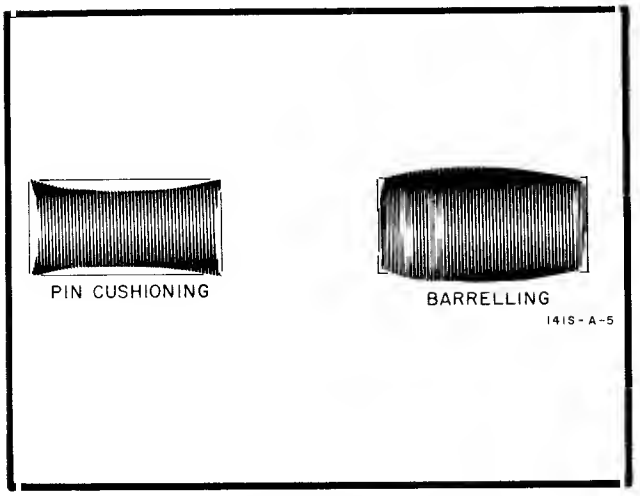


Figure 5-1. Pincushioning and Barreling

5-33. CALIBRATOR.

NOTE

Since the CALIBRATOR signals on this instrument are intended for oscilloscope use, make this adjustment only with oscilloscope plug-ins installed.

a. Set Volts/Div to 2.

b. Connect a 60 Hz, 10V pk-pk signal from the Voltmeter Calibrator to the vertical input.

c. Adjust Time/Div to obtain a satisfactory display, and adjust vertical amplifier sensitivity calibration for 5 vertical divisions.

d. Disconnect the Voltmeter Calibrator, and connect the 10V CALIBRATOR signal from the instrument front panel to the vertical input.

e. Adjust R494 for exactly 5 divisions of vertical deflection.

5-34. CONDENSED ADJUSTMENT PROCEDURE.

5-35. Table 5-3 is a condensed adjustment procedure. The table may be useful after becoming familiar with the step-by-step procedures.

Table 5-3. Condensed Adjustment Procedure

Test	External Equipment Required	Procedure	Adjust
Low Voltage Supplies	DC Voltmeter	Measure -100V (Violet) -12. 6V (White/Violet) +100V (White/Red) +250V	 R471 R488 R453 R432
High Voltage	DC VTVM; 100:1 Divider; Voltmeter	a. Calibrate Divider - Voltmeter combination. b. Measure -2350 v	R619 for -2350 volts.
Intensity Limit	None	Refer to Paragraph 5-27	R612 until spot is just extinguished.
Astigmatism	None	Center a low-intensity spot.	FOCUS and ASTIGMATISM for sharp spot.
Geometry	Oscillator	a. Trigger Level to auto; sweep Time to 0.2 msec/div b. Connect 400 kHz sine wave to vertical input. c. Obtain pattern 8 div high	R643 for straightest edges.
Calibrator	Voltmeter Calibrator	a. Sensitivity to 2V/div b. Apply 10V pk-pk from Voltmeter Calibrator to vertical input. c. Adjust vertical Vernier for 5 div deflection. d. Connect 10V CALIBRATOR to vertical input.	Cal Adj R494 for 5 div.

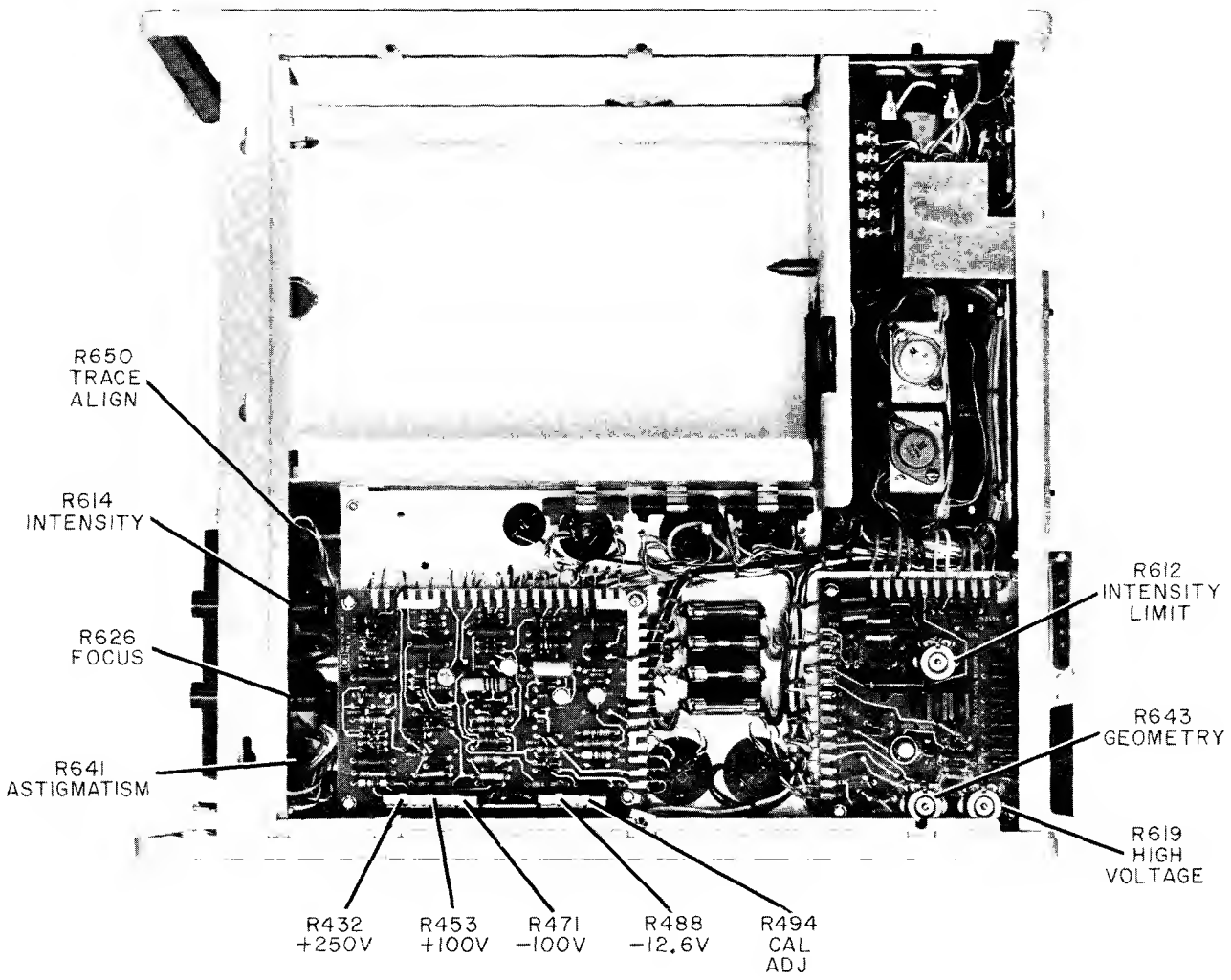


Figure 5-2. Adjustment Locations, Bottom View

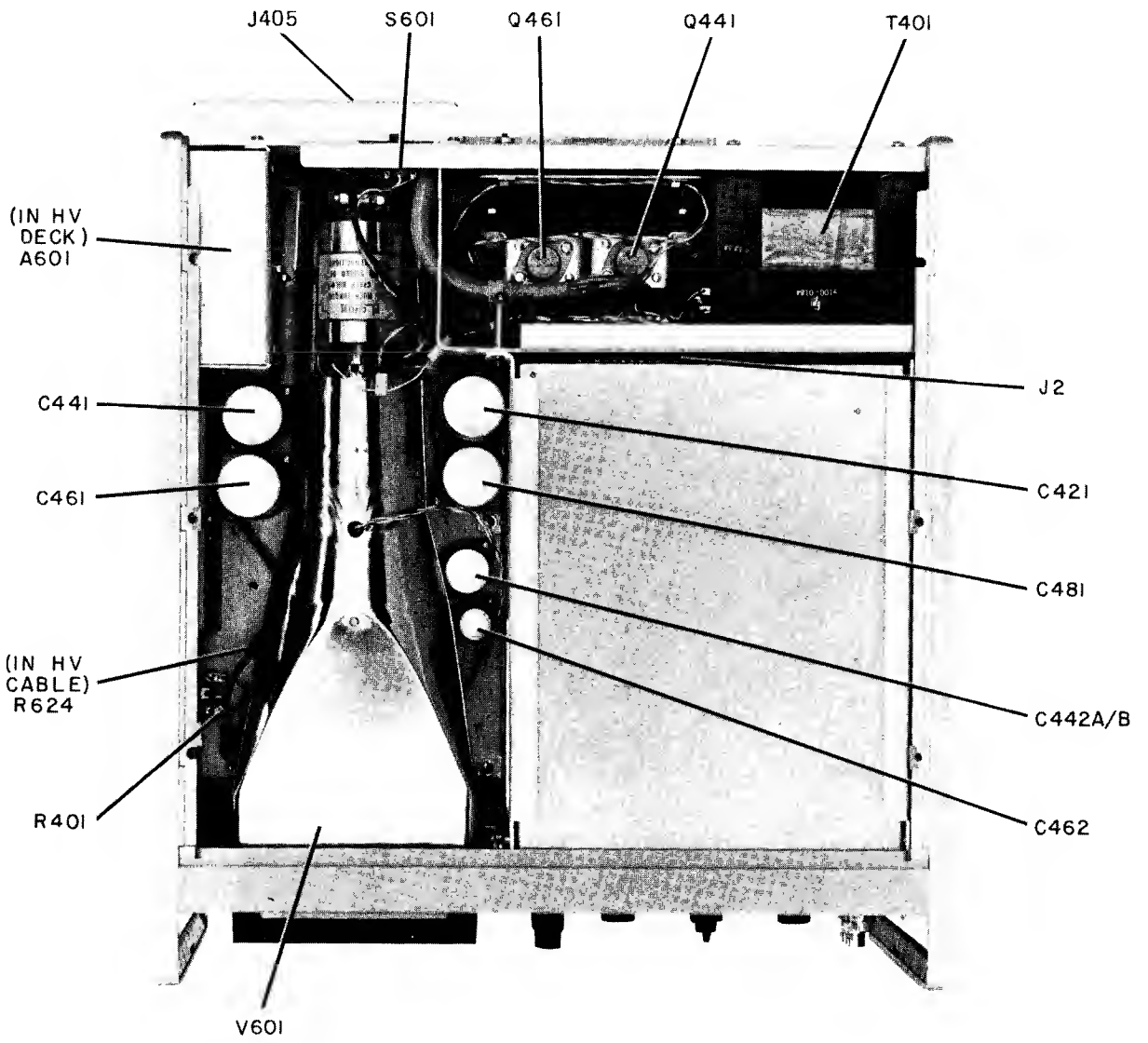
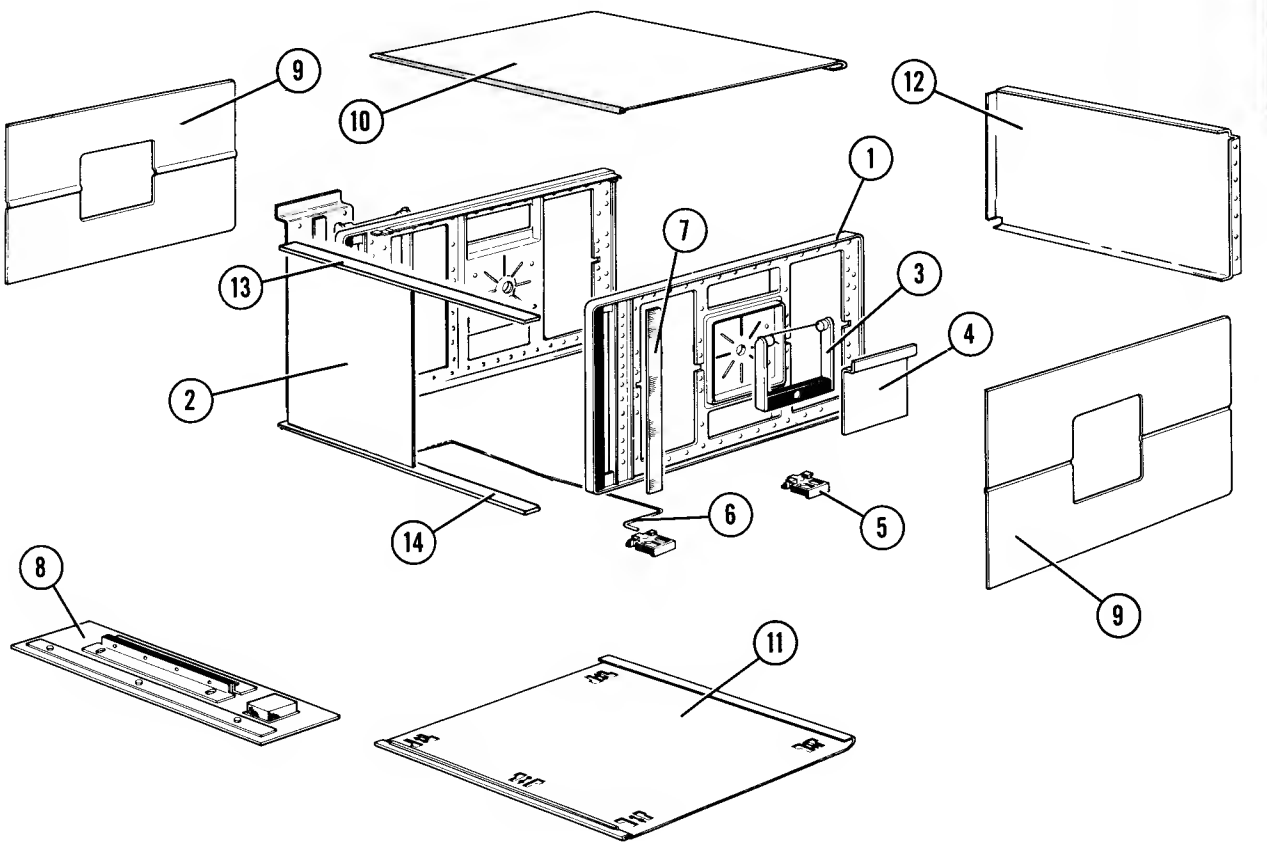


Figure 5-3. Component Locations, Top View



Part	Part Number	Quantity
1. Frame Assembly	5060-0736	2
2. Front Panel	00140-00217	1
3. Side Handle Assembly	5060-0763	2
4. Handle Retainer	5060-0765	2
5. Foot Assembly	5060-0767	5
6. Tilt Stand	1490-0030	1
7. Plastic Trim	00140-29902	2
8. Rack Mount Kit	5060-0777	1
9. Side Cover	5000-0747	2
10. Top Cover Assembly	5060-0740	1
11. Bottom Cover Assembly	00140-04403	1
12. Rear Panel	00140-00212	1
13. Top Panel Support	00140-24701	1
14. Bottom Panel Support	00140-24702	1

Figure 6-1. Cabinet Parts, Exploded View

SECTION VI

REPLACEABLE PARTS

6-1. INTRODUCTION.

6-2. This section contains the information necessary for ordering replaceable parts. Table 6-2 provides the following information:

a. HP Part Number.

b. Total Quantity (TQ) used in the instrument; given only the first time a part number is listed.

c. Description of part; see Table 6-1 for a list of the reference designators and abbreviations used.

6-3. Miscellaneous parts are listed at the end of Table 6-2.

6-4. ORDERING INFORMATION.

6-5. To order replacement part(s), direct the order or inquiry to the nearest Hewlett-Packard Sales/Service Office (see list at back of this manual). Provide the following information:

a. HP Part Number of item(s).

b. Model number and eight-digit serial number of instrument.

c. Quantity of part(s) desired.

6-6. To order a part not listed or identifiable in the table, provide the following information:

a. Model number and eight-digit serial number of instrument.

b. Part description, including function and location.

Note

Upon request, information will be supplied to allow ordering of applicable parts from manufacturers other than Hewlett-Packard. Contact the HP Sales/Service Office for details.

Table 6-1. Reference Designators And Abbreviations

REFERENCE DESIGNATORS

A	= assembly	E	= misc. electronic part	M	= meter	TB	= terminal board
AT	= attenuator, resistive termination	F	= fuse	MP	= mechanical part	TP	= test point
B	= motor, fan	FL	= filter	P	= plug	U	= microcircuit(non-repairable)
C	= capacitor	H	= hardware	PS	= power supply	V	= vacuum tube, neon bulb, photocell, etc.
CP	= coupling	IC	= integrated circuit	Q	= transistor		
CR	= diode	J	= jack	R	= resistor	VR	= voltage regulator (diode)
DL	= delay line	K	= relay	RT	= thermistor	W	= cable
DS	= device signaling (lamp)	L	= inductor	S	= switch	X	= socket
		LS	= speaker	T	= transformer	Y	= crystal

ABBREVIATIONS

A	= ampere(s)	Ge	= germanium	minat	= miniature	s-b	= slow-blow
ampl	= amplifier(s)	G	= giga (10^9)	mom.	= momentary	Se	= selenium
assy	= assembly	gl	= glass	mtg	= mounting	sect	= section(s)
		grd	= ground(ed)	my.	= mylar	semicon	= semiconductor(s)
bd	= board(s)					Si	= silicon
bp	= bandpass	H	= henry(ies)	n	= nano (10^{-9})	sil	= silver
		Hg	= mercury	n/c	= normally closed	sl	= slide
c	= centi (10^{-2})	hr	= hour(s)	Ne	= neon	sp	= single pole
car.	= carbon	HP	= Hewlett-Packard	n/o	= normally open	spl	= special
ccw	= counterclockwise	Hz	= hertz	npo	= negative positive zero (zero temperature coefficient)	st	= single throw
cer	= ceramic					std	= standard
coax.	= coaxial	if.	= intermediate freq				
coef	= coefficient	impg	= impregnated	nsr	= not separately replaceable	Ta	= tantalum
com	= common	incd	= incandescent			td	= time delay
comp	= composition	incl	= include(s)			TD	= tunnel diode(s)
conn	= connector(s)	ins	= insulation(ed)	obd	= order by description	tgl	= toggle
CRT	= cathode-ray tube	int	= internal	ox	= oxide	Ti	= titanium
cw	= clockwise					tol	= tolerance
		k	= kilo (10^3)	p	= pico (10^{-12})	trim	= trimmer
d	= deci (10^{-1})			pc	= printed (etched) circuit(s)		
depc	= deposited carbon	lb	= pound(s)	PGM	= program	u	= micro (10^{-6})
dp	= double pole	lev	= lever	piv	= peak inverse voltage(s)		
dt	= double throw	lin	= linear taper	p/o	= part of	V	= volt(s)
		log.	= logarithmic taper	poly	= polystyrene	var	= variable
elect.	= electrolytic	lpf	= low-pass filter(s)	porc	= porcelain		
encap	= encapsulated			pos	= position(s)	W	= watt(s)
ext	= external	m	= milli (10^{-3})	pot.	= potentiometer(s)	w/	= with
		M	= mega (10^6)	pk-pk	= peak-to-peak	w/o	= without
F	= farad(s)	metflm	= metal film	rect	= rectifier(s)	wVdc	= dc working volt(s)
fet	= field-effect transistor(s)	metox	= metal oxide	rf	= radio frequency	ww	= wirewound
fxd	= fixed						

Table 6-2. Replaceable Parts

Ref Desig	HP Part No.	TQ	Description (See Table 6-1.)
A401	00140-66508	1	A: low voltage supply board
A402	2100-1589	1	A: r var type v, 3 sect 7000, 3000, 5000 ohms 20%
A403	2100-1588	1	A: r var type v, 2 sect 1500 ohms 30% (each)
A601	00140-60404	1	A: high voltage rectifier board
	00140-66404	1	A: high voltage deck (includes A601 and Q602)
A602	00141-66508	1	A: high voltage regulator board
B401	3160-0218	1	B: fan assembly
C420	0150-0052	4	C: fxd cer 0.05 uF 20% 400 wVdc
C421	0180-0154	1	C: fxd elect. 430 uF -10 +100% 250 wVdc
C422A/B	0180-0012	1	C: fxd elect. 2 x 20 uF -10 +100% 450 wVdc
C423	0160-0168	4	C: fxd my. 0.1 uF 10% 200 wVdc
C424	0160-0168		C: fxd my. 0.1 uF 10% 200 wVdc
C425 - C439			Not assigned
C440	0150-0052		C: fxd cer 0.05 uF 20% 400 wVdc
C441	0180-0046	1	C: fxd elect. 600 uF -10 +75% 200 wVdc
C442	0160-0168		C: fxd my. 0.1 uF 10% 200 wVdc
C443	0180-0100	2	C: fxd elect. 4.7 uF 10% 35 wVdc
C444 - C459			Not assigned
C460	0150-0052		C: fxd cer 0.05 uF 20% 400 wVdc
C461	0180-0214	1	C: fxd elect. 275 uF -10 +50% 200 wVdc
C462	0180-0093	1	C: fxd elect. 20 uF -10 +100% 150 wVdc
C463	0160-0168		C: fxd my. 0.1 uF 10% 200 wVdc
C464	0180-0100		C: fxd elect. 4.7 uF 10% 35 wVdc
C465 - C480			Not assigned
C481	0180-0213	1	C: fxd elect. 5000 uF -10 +75% 25 wVdc
C482	0160-0207	1	C: fxd my. 0.01 uF 5% 200 wVdc
C483	0180-0097	1	C: fxd elect. 47 uF 10% 35 wVdc
C484 - C600			Not assigned
C601	0150-0052		C: fxd cer 0.05 uF 20% 400 wVdc
C602	0180-0138	1	C: fxd elect. 100 uF -10 +100% 40 wVdc
C603	0170-0040	1	C: fxd my. 0.047 uF 10% 200 wVdc
C604 - C609			Not assigned
C610	0160-0151	6	C: fxd cer 4700 pF -20 +80% 4000 wVdc
C611	0150-0036	2	C: fxd cer 470 pF 20% 6000 V

Table 6-2. Replaceable Parts (Cont'd)

Ref Desig	HP Part No.	TQ	Description (See Table 6-1.)
C612	0150-0036		C: fxd cer 470 pF 20% 6000 V
C613	0160-0151		C: fxd cer 4700 pF -20 +80% 4000 wVdc
C614	0160-0151		C: fxd cer 4700 pF -20 +80% 4000 wVdc
C615	0160-0151		C: fxd cer 4700 pF -20 +80% 4000 wVdc
C616	0160-0907	2	C: fxd cer 0.01 uF -20 +80% 5000 wVdc
C617 - C620			Not assigned
C621	0160-0151		C: fxd cer 4700 pF -20 +80% 4000 wVdc
C622	0160-0151		C: fxd cer 4700 pF -20 +80% 4000 wVdc
C623	0160-0907		C: fxd cer 0.01 uF -20 +80% 5000 wVdc
CR421	1901-0028	12	CR: Si
CR422	1901-0028		CR: Si
CR423	1901-0028		CR: Si
CR424	1901-0028		CR: Si
CR425	1910-0016	2	CR: Ge
CR426	1902-0034	1	CR: breakdown 5.76 V 10% 400 mW
CR427	1901-0096	1	CR: Si
CR428	1902-3402	1	CR: breakdown 80.6 V 2% 400 mW
CR429	1901-0040	8	CR: Si
CR430	1901-0040		CR: Si
CR441	1901-0028		CR: Si
CR442	1901-0028		CR: Si
CR443	1901-0028		CR: Si
CR444	1901-0028		CR: Si
CR445	1902-3385	2	CR: breakdown 69.8 V 2% 400 mW
CR446	1901-0026	2	CR: Si
CR447	1901-0040		CR: Si
CR448	1901-0040		CR: Si
CR449	1902-3104	1	CR: breakdown 5.62 V 5% 400 mW
CR461	1901-0028		CR: Si
CR462	1901-0028		CR: Si
CR463	1901-0028		CR: Si
CR464	1901-0028		CR: Si
CR465	1902-3385		CR: breakdown 69.8 V 2% 400 mW
CR466	1901-0026		CR: Si
CR467	1901-0040		CR: Si
CR468	1901-0040		CR: Si
CR481	1901-0032	2	CR: rect Si 15 A 1N3209
CR482	1901-0032		CR: rect Si 15 A 1N3209
CR483	1901-0025	1	CR: Si
CR484	1910-0016		CR: Ge
CR485	1901-0040		CR: Si

Table 6-2. Replaceable Parts (Cont'd)

Ref Desig	HP Part No.	TQ	Description (See Table 6-1.)
CR490	1912-0006	1	CR: Ge tunnel 1N3718
CR491	1902-0064	1	CR: breakdown 7.50 V 400 mW
CR492 - CR601			Not assigned
CR602	1901-0487	2	CR: Si
CR603	1901-0487		CR: Si
CR604	1901-0049	2	CR: Si
CR605	1901-0049		CR: Si
CR606	1880-0025	2	CR: Se
CR607	1880-0025		CR: Se
CR608	1901-0341	1	CR: Si
CR609	1901-0040		CR: Si
DS401	1450-0048	1	DS: Ne
F401	2110-0014	1	F: cartridge 4 A s-b (115 V Operation)
	2110-0006	1	F: cartridge 2 A s-b (230 V Operation)
F402 - F420			Not assigned
F421	2110-0004	1	F: cartridge 0.25 A 250 V
F422 - F440			Not assigned
F441	2110-0033	1	F: 0.75 A 250 V
F442 - F460			Not assigned
F461	2110-0012	1	F: cartridge 0.5 A 250 V
F462 - F480			Not Assigned
F481	2110-0003	1	F: cartridge 3 A 3 AG
FL401	9100-0218		FL: line
J1	1251-0054	2	J: 24 contact
J2	1251-0054		J: 24 contact
J3 - J400			Not assigned
J401	1251-0148		J: receptacle ac power
J402	1251-0202	2	J: calibrator
J403	1251-0202		J: calibrator
J404	1251-2366	1	J: accessory cable
J405	1251-2367	1	J: accessory cable
L601	9140-0171	1	L: fxd 40 uH 10% 1 A
L602	5060-0435	1	L: alignment, trace
L603	9140-0179	1	L: fxd 22 uH 10%

Table 6-2. Replaceable Parts (Cont'd)

Ref Desig	HP Part No.	TQ	Description (See Table 6-1.)
Q421	1850-0422	1	Q: Ge pnp
Q422	1854-0005	1	Q: Si npn 2N708
Q423	1853-0036	1	Q: Si pnp 2N3906
Q424 - Q440			Not assigned
Q441	1854-0294	3	Q: Si npn
Q442	1854-0022	2	Q: Si npn
Q443	1854-0087	1	Q: Si npn 2N3417
Q444	1854-0071	4	Q: Si npn 2N3391
Q445 - Q460			Not assigned
Q461	1854-0294		Q: Si npn
Q462	1854-0022		Q: Si npn
Q463	1854-0071		Q: Si npn 2N3391
Q464	1854-0071		Q: Si npn
Q465 - Q480			Not assigned
Q481	1854-0294		Q: Si npn
Q482	1854-0039	1	Q: Si npn 2N3053
Q483	1854-0215	1	Q: Si npn 2N3904
Q484	1854-0071		Q: Si npn 2N3391
Q485 - Q489			Not assigned
Q490	1850-0062	1	Q: Ge pnp 2N404
Q491 - Q600			Not assigned
Q601	1853-0016	1	Q: Si pnp
Q602	1853-0084	1	Q: Si pnp 2N4918
R401	0687-3331	1	R: fxd comp 33 k ohms 10% 1/2 W
R402 - R420			Not assigned
R421	0687-1041	1	R: fxd comp 100 k ohms 10% 1/2 W
R422A/B	0815-0031	1	R: fxd ww 2400 ohms CT 5%
R423	0764-0033	1	R: fxd metox 33 ohms 5% 2 W
R424	0761-0007	1	R: fxd metox flm 27 k ohms 5% 1 W
R425	0757-0401	3	R: fxd metflm 100 ohms 1% 1/8 W
R426	0757-0413	1	R: fxd metflm 392 ohms 1% 1/8 W
R427	0757-0044	1	R: fxd metflm 33.2 k ohms 1% 1/2 W
R428	0757-0401		R: fxd metflm 100 ohms 1% 1/8 W
R429	0757-0465	2	R: fxd metflm 100 k ohms 1% 1/8 W
R430	0757-0273	2	R: fxd metflm 3010 ohms 1% 1/8 W
R431	0757-0370	1	R: fxd metflm 49.9 k ohms 1% 1/2 W
R432			NSR: p/o A402

Table 6-2. Replaceable Parts (Cont'd)

Ref Desig	HP Part No.	TQ	Description (See Table 6-1.)
R433	0757-0367	1	R: fxd metflm 100 k ohms 1% 1/2 W
R434	0761-0006	1	R: fxd metflm 10 k ohms 5% 1 W
R435	0684-1021	3	R: fxd comp 1000 ohms 10% 1/4 W
R436 - R440			Not assigned
R441	0687-5631	4	R: fxd comp 56 k ohms 10% 1/2 W
R442	0811-2030	2	R: fxd ww 14 ohms 5% 10 W
R443	0687-5631		R: fxd comp 56 k ohms 10% 1/2 W
R444			Not assigned
R445	0684-1021		R: fxd comp 1000 ohms 10% 1/4 W
R446	0757-0399	2	R: fxd metflm 82.5 ohms 1% 1/8 W
R447	0684-5621	1	R: fxd comp 5600 ohms 10% 1/4 W
R448			Not assigned
R449	0757-0764	2	R: fxd metflm 33.2 k ohms 1% 1/4 W
R450 - R451			Not assigned
R452	0757-0436	2	R: fxd metflm 4320 ohms 1% 1/2 W
R453			NSR: p/o A402
R454	0757-0846	3	R: fxd metflm 22.1 k ohms 1% 1/2 W
R455	0766-0033	1	R: fxd metflm 2000 ohms 1% 3 W
R456	0757-0434	1	R: fxd metflm 3650 ohms 1% 1/2 W
R457	0757-0388	3	R: fxd metflm 30.1 ohms 1% 1/8 W
R461	0687-5631		R: fxd comp 56 k ohms 10% 1/2 W
R462	0811-2030		R: fxd ww 14 ohms 5% 10 W
R463			Not assigned
R464	0684-1021		R: fxd comp 1000 ohms 10% 1/4 W
R465	0687-5631		R: fxd comp 56 k ohms 10% 1/2 W
R466	0757-0399		R: fxd metflm 82.5 ohms 1% 1/8 W
R467	0757-0848	1	R: fxd metflm 30.1 k ohms 1% 1/8 W
R468	0757-0772	1	R: fxd metflm 68.1 k ohms 1% 1/4 W
R469	0757-0764		R: fxd metflm 33.2 k ohms 1% 1/4 W
R470	0757-0436		R: fxd metflm 4320 ohms 1% 1/2 W
R471			NSR: p/o A402
R472	0757-0846		R: fxd metflm 22.1 k ohms 1% 1/2 W
R473	0757-0190	2	R: fxd metflm 20 k ohms 1% 1/2 W
R474	0757-0388		R: fxd metflm 30.1 ohms 1% 1/8 W
R475	0727-0431	1	R: fxd metflm 2690 ohms 1% 1/2 W
R481	0687-2221	1	R: fxd comp 2200 ohms 10% 1/2 W
R482	0687-4731	1	R: fxd metflm 47 k ohms 1% 1/2 W
R483	0811-1746	2	R: fxd ww 0.36 ohms 5% 2 W
R484	0757-0388		R: fxd metflm 30.1 ohms 1% 1/8 W
R485	0757-0190		R: fxd metflm 20 k ohms 1% 1/2 W

Table 6-2. Replaceable Parts (Cont'd)

Ref Desig	HP Part No.	TQ	Description (See Table 6-1.)
R486	0757-0480	1	R: fxd metflm 432 k ohms 1% 1/8 W
R487	0757-0273		R: fxd metflm 3010 ohms 1% 1/8 W
R488			NSR: p/o A403
R489	0757-0846		R: fxd metflm 22.1 k ohms 1% 1/2 W
R490	0811-1746		R: fxd ww 0.36 ohms 5% 2 W
R491	0757-0421	1	R: fxd metflm 825 ohms 1% 1/8 W
R492	0757-0428	1	R: fxd metflm 1620 ohms 1% 1/8 W
R493	0757-0844	1	R: fxd metflm 16.2 k ohms 1% 1/2 W
R494			NSR: p/o A403
R495	0698-3555	1	R: fxd metflm 4437 ohms 1/2% 1/2 W
R496	0698-3554	1	R: fxd metflm 493 ohms 1/2% 1/2 W
R497 - R600			Not assigned
R601	0757-0401		R: fxd metflm 100 ohms 1% 1/8 W
R602 - R604			Not assigned
R605	0757-0438	1	R: fxd metflm 5110 ohms 1% 1/8 W
R606 - R609			Not assigned
R610	0683-2245	1	R: fxd comp 220 k ohms 5% 1/4 W
R611	0683-1535	1	R: fxd comp 15 k ohms 5% 1/2 W
R612	2100-0096	2	R: var comp 1 megohm 30% lin 1/5 W
R613	0757-0280		R: fxd metflm 1000 ohms 1% 1/8 W
R614	2100-0756	1	R: var comp 1.5 megohm
R615	0698-6666	1	R: fxd depc 33 megohms 5% 1 W
R616	0757-0344	2	R: fxd metflm 1 megohm 1% 1/4 W
R617	0757-0449	1	R: fxd metflm 20 k ohms 1% 1/8 W
R618	0757-0768	2	R: fxd metflm 47.5 k ohms 1% 1/4 W
R619	2100-0096		R: var comp 1 megohm 30% lin 1/5 W
R620	0727-0845	3	R: fxd car flm 1.78 megohms 1% 1/2 W
R621	0727-0845		R: fxd car flm 1.78 megohms 1% 1/2 W
R622	0757-0768		R: fxd metflm 47.5 k ohms 1% 1/4 W
R623			Not assigned
R624	0687-2241	1	R: fxd comp 220 k ohms 10% 1/2 W
R625	0727-0845		R: fxd car flm 1.78 megohms 1% 1/2 W
R626	2100-0374	1	R: var comp 5 megohms 30% lin 1/2 W
R627	0698-3553	8	R: fxd car flm 2.49 megohms 1% 1/2 W
R628	0698-3553		R: fxd car flm 2.49 megohms 1% 1/2 W
R629	0698-3553		R: fxd car flm 2.49 megohms 1% 1/2 W
R630	0698-3553		R: fxd car flm 2.49 megohms 1% 1/2 W
R631	0698-3553		R: fxd car flm 2.49 megohms 1% 1/2 W
R632	0698-3553		R: fxd car flm 2.49 megohms 1% 1/2 W

Table 6-2. Replaceable Parts (Cont'd)

Ref Desig	HP Part No.	TQ	Description (See Table 6-1.)
R633	0698-3553		R: fxd car flm 2.49 megohms 1% 1/2 W
R634	0698-3553		R: fxd car flm 2.49 megohms 1% 1/2 W
R635 - R640			Not assigned
R641	2100-0212	1	R: var comp 100 k ohms 10% lin 2 W
R642	0757-0454	1	R: fxd metflm 33.2 k ohms 1% 1/8 W
R643	2100-0095	1	R: var comp 100 k ohms 30% lin 1/5 W
R644	0757-0772	1	R: fxd metflm 68.1 k ohms 1% 1/4 W
R645	0757-0437	1	R: fxd metflm 4750 ohms 1% 1/8 W
R646 - R649			Not assigned
R650A/B	2100-0445	1	R: var comp 2 x 2000 ohms 30% lin
R651	0757-0452	1	R: fxd metflm 27.4 k ohms 1% 1/8 W
R652	0757-0465		R: fxd metflm 100 k ohms 1% 1/8 W
R653	0757-0344		R: fxd metflm 1 megohm 1% 1/4 W
S401	3101-0030	1	S: tgl
S402	3101-0033	1	S: sl
S403	3103-0009	1	S: thermal
S404 - S600			Not assigned
S601	3101-0011	1	S: sl
S602	3101-0048	1	S: pushbutton
T401	9100-0184	1	T: power
T402 - T600			Not assigned
T601	00140-86001	1	T: high voltage
TB601	0360-0104	1	Terminal strip, Z-Axis
V441	1940-0013	1	V: reference 82.0 ±1.0 V
V442 - V600			Not assigned
V601	1921-0013	1	V: 6CW4
V602 - V603			Not assigned
V604	1920-0001	1	V: 5642
V605			Not assigned
V606	2140-0008	1	V: neon NE2
V607	2140-0014	2	V: neon NE96
V608	2140-0014		V: neon NE96
V609			Not assigned
V610	5083-9093	1	V: cathode-ray
W401	8120-0078	1	W: power cord
XV601	1200-0086	1	XV: nuvistor 5 pin

Table 6-2. Replaceable Parts (Cont'd)

Ref Desig	HP Part No.	TQ	Description (See Table 6-1.)
			MISCELLANEOUS
	5020-0476	1	Bezel: CRT
	175A-91	2	Spring: CRT contact
	0360-0362	1	Strip: diode terminal
	0370-0084	2	Knob: intensity and focus w/arrow
	0510-0123	1	Clamp: pilot light retainer
	0905-0016	1	Gasket: felt
	1200-0037	1	Socket: CRT
	1200-0043	4	Insulator: anodized aluminum
	1200-0050	7	Pin: CRT socket
	1200-0063	2	Clip: transistor
	1200-0085	1	Cover: CRT socket
	1200-0088	4	Insulator: anodized aluminum
	1251-0207	45	Connector: edge-on, 1/16 inch
	1520-0042	4	Mount: vibration
	2950-0034	2	Nut: hex, 11/16 inch
	4320-0007	7	Extrusion: rubber
	5000-0408	3	Bracket: coil
	5040-0400	4	Support: cap
	5040-0401	4	Support: cap
	5040-0430	2	Mount: transformer
	5040-0421	2	Insulator: potentiometer
	5040-0440	1	Cover: CRT socket access
	5060-0428	1	Filter: air
	7123-0092	1	Label: CRT shield
	8150-1200	1	Lead: electrical CRT anode
	00140-00602	1	Shield: plug-in
	00140-00109	1	Deck: vertical
	00140-00111	1	Gusset: center
	00140-00104	1	Gusset: side
	00140-60101	1	Deck: main
	00140-01201	1	Bracket: latch
	00140-01212	1	Bracket: diode
	00140-01206	2	Bracket: fan
	00140-01208	4	Bracket: panel
	00140-01209	2	Bracket: gusset
	00140-01210	2	Bracket: transistor
	00140-24703	4	Support: panel bracket
	00140-44701	2	Spacer: cable, foam
	00140-44702	5	Spacer: cable, foam

Table 6-2. Replaceable Parts (Cont'd)

Ref Desig	HP Part No.	TQ	Description (See Table 6-1.)
	00140-60602	1	Shield: CRT
	00140-61606	1	Cable: high voltage
	00140-61613	1	Cable: primary power
	00140-61618	1	Cable: main, internal
	5040-0444	1	Shield, Light
	01200-44703	1	Support, CRT shield
	0340-0451	1	Washer, Mica (under Q602)
	00140-29902	1	Front Panel Support and Trim Strip

SECTION VII

MANUAL CHANGES AND OPTIONS

7-1. MANUAL CHANGES.

7-2. This manual applies directly to the standard Model 140T with the serial prefix as listed on the title page. The following paragraphs provide instructions and information for adapting this manual to cover newer or older instruments. Refer to the Manual Changes sheet supplied with this manual for Errata.

7-3. OLDER INSTRUMENTS.

7-4. Table 7-1 contains information to adapt this manual to cover an older instrument (lower serial prefix). Check Table 7-1 for your instrument serial prefix and make the indicated changes to this manual. These changes adapt the manual to instruments as manufactured and do not apply to field modified instruments.

Table 7-1. Manual Changes

Serial Prefix	Make Changes
No backdating changes are required at this time.	

7-5. NEWER INSTRUMENTS.

7-6. As changes and improvements are made to the Model 140T subsequent instruments may have a higher serial prefix than that listed on the title page. If the serial prefix of your instrument does not match that on the title page, a Manual Changes sheet supplied with the manual provides the information to adapt this manual to cover the newer instument.

7-7 If the serial prefix of your instrument and that on the title page of this manual do not agree and no Manual Changes sheet was supplied, contact the nearest Hewlett-Packard Sales/Service Office.

7-8. OPTIONS.

7-9. Options for an HP instrument are standard factory installed modifications. At the present time, no options are offered for the Model 140T.

7-10. SPECIAL INSTRUMENTS.

7-11. Special instruments are instruments that are modified to meet special specifications. To cover the modifications in a special instrument, an insert sheet is supplied with the manual for that instrument. This insert sheet contains the instructions for operating, adjusting, and maintaining the special instrument.

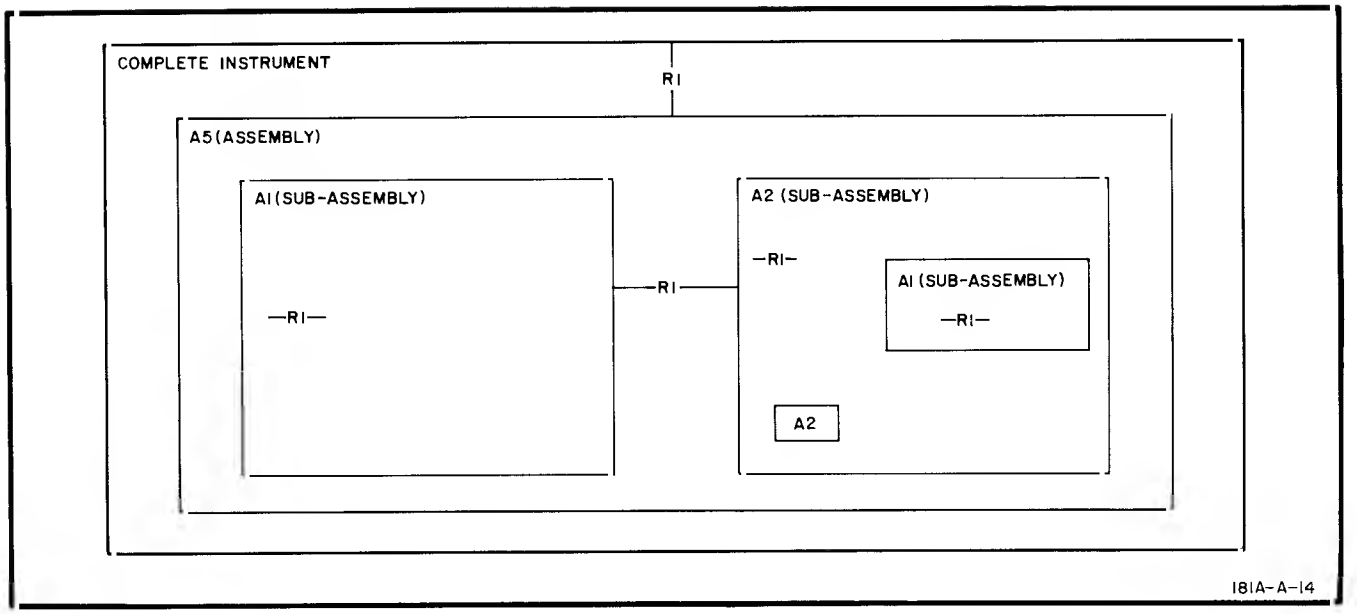


Figure 8-1. Unit System Reference Designation

SECTION VIII

SCHEMATICS AND TROUBLESHOOTING

8-1. INTRODUCTION.

8-2. This section contains schematics and component location photographs along with troubleshooting, repair and replacement information. All schematics are on pull-out pages to allow reference to the text and figures in other sections. Schematic symbols and conventions are explained in Table 8-3 and Figure 8-6 shows plug-in jack connections. An over-all block diagram is in Section IV.

8-3. SCHEMATICS.

8-4. Schematics are on right hand pages that unfold outside the right edge of the manual. The throw clear pages allow viewing the schematics while referring to another section. Text can be followed by unfolding the appropriate throw clear page.

8-5. Schematics are drawn primarily to show the electronic function of an instrument. A given schematic may include all or part of several assemblies. Schematics also include dc voltages and waveform measurement test points. Waveforms applicable to each schematic are shown opposite that schematic. DC voltage and waveform measurement conditions are shown above the waveforms. Information about symbols and conventions used on these schematics is provided by Table 8-3.

8-6. COMPONENT LOCATION.

8-7. Assembly components are shown, with a grid locator, near each schematic for ease of location. All internal adjustments are shown in Figure 5-2. Chassis mounted components are shown in Figure 5-3, and mechanical parts listed in the replaceable parts list are shown in the appropriate assembly photograph.

8-8. REFERENCE DESIGNATIONS.

8-9. The unit system of reference designation, used in this manual, is in accordance with the provisions of the American Standard Electrical and Electronics Reference Designations. Minor variations, due to design and manufacturing, may be noted. A brief explanation is presented here for those unfamiliar with the designation system.

8-10. Each component is identified by a letter-number combination. For example R1, R2,. . . C1, C2; etc. This letter-number combination is the basic designation for each component. Components which are separately replaceable and are part of an assembly have, in addition to the basic designator, a prefix designation which identifies the assembly on which the component is located. Components not mounted on an assembly have only the basic reference disignation.

8-11. Figure 8-1 is used as an example. The basic reference designation (R1) appears four times, however each R1 is identified by a designation formed by combining component, assembly and sub-assembly designators. Consider the R1 on subassembly A1. The complete designation of that resistor is A2A1R1. Now, R1 connected between assembly A1 and the complete instrument has only the designation R1 because it is not mounted on an assembly. This system applies to all classes of components, C, CR, Q, etc.

8-12. OVER-ALL TROUBLESHOOTING.

8-13. Troubleshooting is much easier if more than one symptom of a trouble is evident. Observe the instrument and note all indications of faulty operation. If symptoms indicate more than one trouble, treat each problem individually and locate one trouble at a time. Follow the logical procedure presented here, and refer to other areas of information in this manual if necessary.

8-14. FRONT-PANEL CONTROLS.

8-15. Equipment troubles are frequently due simply to improper front-panel control settings. Refer to the operating instructions in Section III for a complete explanation of each control's function along with typical operating instructions. Also, refer to the operating information in the plug-in manuals. Possibly the intensity control isn't turned up, or the level control on a time base plug-in is misadjusted. Use the controls as a guide to help isolate a trouble to a specific area.

8-16. VISUAL CHECKS.

8-17. After localizing the trouble to a specific area of the instrument, make a good visual check of that area. Check for burned or broken components, loose wires or circuit board connections, faulty switch contacts, or any similar condition suggesting a source of trouble. If everything appears normal, proceed to the next step.

8-18. VOLTAGE CHECKS.

8-19. Allow the instrument to warm-up for about fifteen minutes. DC voltages are shown on the schematics near active components such as transistors. To avoid creating a short circuit, use a probe with a needle tip when taking

voltage measurements. Check voltages at J1 and J2, as shown in the plug-in jack drawing, to ensure that the proper voltages are being applied to the plug-ins. As an aid to locating measurement points, note a small dot etched on the circuit boards near the emitter of transistors, source of field effect transistors, cathode of diodes and positive lead to electrolytic capacitors.

8-20. DETAILED TROUBLESHOOTING.

8-21. The following troubleshooting tips are categorized according to the various areas of the instrument. These tips can be helpful only after a trouble is localized to one of these areas. Therefore, refer to the above information before reading further. Also, read the theory of operation in Section IV to learn how a circuit should operate. With the aid of this information, it is easier to discover why a defective circuit is inoperative. Finally, make resistance checks to uncover the faulty component. If it appears necessary to calibrate the instrument, refer to Section V for the proper procedures.

8-22. LOW-VOLTAGE SUPPLIES.

8-23. TRANSISTORS. The series regulator transistors are located on the fan assembly. Each is easily replaced by removing the two screws and pulling the transistor from its socket. All other low voltage power supply transistors are located on the low-voltage circuit board.

8-24. DC voltages shown on the low voltage schematic diagram were measured, to ground, with Model 1402A and 1421A plug-ins installed. Voltages may vary slightly when other plug-ins are used. Voltages for points not marked for voltage are generally obvious by being connected (directly or indirectly) to a supply output. Transistor base voltage, in most cases, should not differ by more than about 0.6V from emitter voltages when measured with respect to ground. Voltage drops across breakdown diodes are indicated on the schematic.

8-25. EXCESSIVE RIPPLE. Excessive 120 Hz ripple on any supply can be traced to either input filter or regulator circuits by comparing ripple voltages at the rectifier outputs with values on the schematic. For ripple above specified value, check C421, C441, C461, or C481. 60 Hz ripple above specified value at these points indicates an open rectifier or low-gain amplifier transistors. Maximum ripple on supply outputs (at 115 Vac with maximum load on supply) is: 10 mV at +250V; 7 mV at +100V and -100V; and 2 mV at -12.6V.

8-26. FUSES. If the -12.6, -100, +100, or +250 volts supply is accidentally shorted to ground, the fuse for that particular supply will open. This cuts off current in the supply and protects the transistors.

8-27. The -12.6 volt supply if fused, and employs a current limiter, Q483, for protection against brief output overloads. The supply should function normally upon removal of the overload, provided the fuse did not open.

8-28. ISOLATING TROUBLES. Trouble in the +100 volt supply can be reflected in the operation of all other low voltage power supply outputs. If +100 volt is correct, follow these steps in order:

a. Check the -100 volt supply. The +250 volt and -12.6 volt supplies are referenced to this supply and a fault in the -100 volt supply can cause apparent malfunction of both. If the -100 volt supply is incorrect, circuit repair may eliminate trouble in the +250 volt or -12.6 volt supply. If the -100 volt supply is correct, proceed to the next step.

b. The +250 volt supply is referenced to the -100 volt supply. If trouble here has not been eliminated by checking the -100 volt supply, the trouble is in this circuit.

c. A trouble that appeared to be in the -12.6 volt supply may have been eliminated by the above procedures. If not, it is necessary to make voltage and component checks of the supply.

8-29. HIGH-VOLTAGE SUPPLY.

8-30. If one high-voltage supply output is zero but other outputs are normal, one of the rectifiers is likely at fault. Normal dc voltages are on the high voltage schematic.

8-31. If there is no high-voltage output, observe the waveform at the collector of Q602 (blue wire). If an approximately 30 kHz 20-volt peak-to-peak sine wave appears for short intervals, the trouble is probably a defective component in the rectifier filter/divider networks. If there is no waveform, refer to Table 8-1.

8-32. If the high-voltage output is incorrect and cannot be adjusted to the correct value, refer to Table 8-2.

8-33. If the -2350 volt supply is operating properly, the +5kV post-accelerator potential may be checked by removing the cover on the left side of the instrument and measuring the 5 kV voltage at the board termination (thick red lead).

8-34. REPAIR AND REPLACEMENT.

8-35. The following paragraphs contain recommended procedures for repair and replacement of defective components. A complete list of components, with Hewlett-Packard part numbers and ordering information, can be found in Section VI. Contact the nearest HP Sales/Service Office listed at the rear of this manual if satisfactory repair or operation cannot be achieved.

8-36. PERIODIC MAINTENANCE.

8-37. ELECTRICAL MAINTENANCE. Perform the

Table 8-1. Troubleshooting High-Voltage Supply, No Voltage

1. Check Q602, L601, and the associated transformer primary for open circuits or shorts. Replace any defective components.

Procedure	Indication	Conclusion
2. Disconnect the edge-on connector to the emitter of Q601 (yellor wire). Connect this lead through a 2000 ohm resistor to -12.6 volts (any white-violet wire).	Rectifier (V604) filament lights. Filament does not light	Proceed to step 3. Proceed to step 4.
3. Replace edge-on connector, and change V601.	Filament lights. Filament does not light.	Q601 failed. Check biasing circuit of V601. Then check Q601 and associated circuit.
4. Check T601 and rectifier load circuit for opens or shorts. Then lift one lead of C613, C614, C616, C617, C621, and turn on instrument again.	Filament lights. Filament does not light.	Put capacitors back, one at a time, until the defective one causes the filament to go out. Trouble is probably transformer T601.

Table 8-2. Troubleshooting High-Voltage Supply, Incorrect Voltage

Procedure	Effect	Conclusion
1. Remove nuvistor V601 from socket.	Output drops to zero. Output remains at an incorrect value.	Proceed to step 2. Q601 shorted.
2. Replace V601 in socket, and lift end of R601.	Output drops. Output remains at an incorrect value.	Trouble is probably in resistor divider network R611, R619-R634. V601 defective.

electrical adjustment procedure, given in Section V, once every six months and after repair or component replacement.

8-38. MECHANICAL MAINTENANCE. Inspect and clean the air filter at the rear of the instrument before it becomes clogged and restricts air flow. To clean, wash the air filter throughly in warm water and detergent, and dry before installing in the instrument. Oil the fan (one point) with light machine oil such as SAE No. 10 every 6 months.

8-39. ASSEMBLY REMOVAL AND INSTALLATION.

8-40. Many components can be replaced from the component side of a circuit board without removing the entire board from the instrument. Refer to the paragraph headed Servicing Etched Circuit Boards in the following text for further information.

8-41. If it becomes necessary to remove a circuit board, remove the clip-on wires and retaining screws. Refer to the applicable component identification photograph for the proper wire-to-pin connections.

8-42. CRT REMOVAL AND REPLACEMENT.

8-43. To remove the CRT, proceed as follows:

WARNING

To prevent personal injury, always wear a face mask or goggles and gloves when handling the CRT. Handle the CRT carefully.

a. Remove top cover of instrument.

b. Discharge post-accelerator lead and its CRT connection to chassis ground. Remove post-accelerator lead from CRT.

c. Disconnect clip-on lead from CRT neck.

d. Remove CRT light shield and bezel from front panel.

e. Loosen clamp at CRT socket.

f. Carefully remove socket from CRT base.

g. Place one hand on CRT face and, with the other hand, slide CRT forward and out of the instrument.

h. To replace the CRT, reverse the procedure.

i. Check the trace alignment and geometry adjustments, Section V.

8-44. FAN REMOVAL AND REPLACEMENT.

8-45. Use the following procedure for removing (reverse procedure for replacing) the cooling fan.

a. Remove the top and bottom covers.

b. Disconnect white-gray (98) and white-green-gray (958) wires from fan terminals.

c. Remove the transistor heat sinks from fan assembly, and move them out of the way.

d. Remove four fan mounting nuts from instrument rear panel.

e. Lift out fan assembly.

8-46. H-V DECK REMOVAL AND REPLACEMENT.

8-47. Most of the components on the high voltage deck can be replaced without removing the assembly. Other components can be replaced by moving the deck part way out (without disconnecting wires). Refer to Figure 8-1 for mounting screw and wire identification; use the following procedure for removing the high voltage deck.

a. Remove left side and top covers.

b. Disconnect six wires from the board and remove the four board mounting screws; see Figure 8-2 for wire and screw identification.

c. Disconnect the post-accelerator lead from CRT as described in Paragraph 8-43 b.

d. Push the wires aside, tilt deck away from the left side of instrument and lift out.

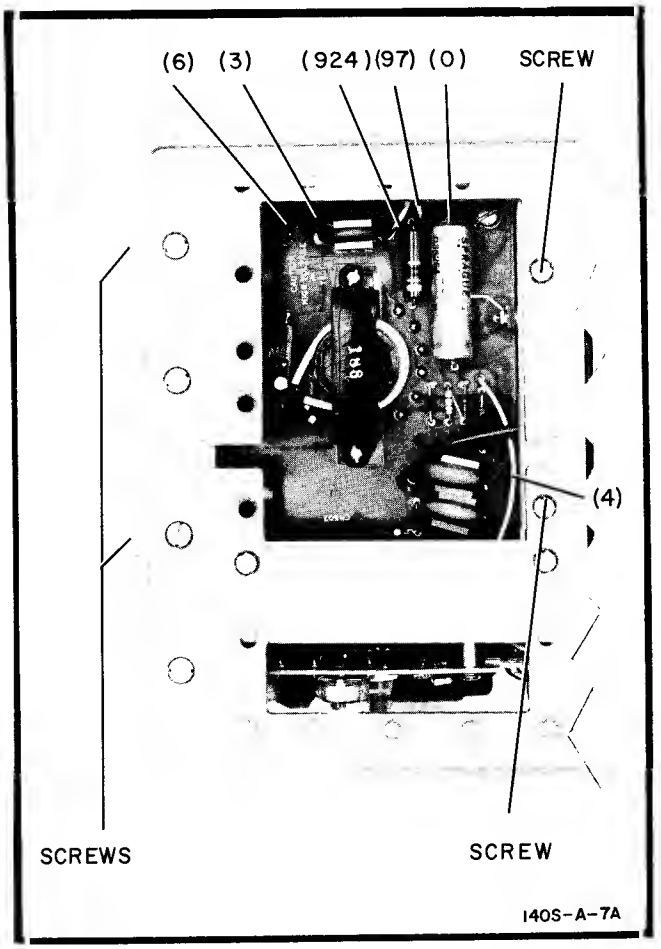


Figure 8-2. High Voltage Rectifier Deck Removal

8-48. SERVICING ETCHED CIRCUIT BOARDS.

8-49. Circuit boards in this instrument have plated through holes with conductive surfaces on both sides. Components can be removed or replaced by unsoldering from either side of a board. When removing a large component, such as a potentiometer, rotate the soldering iron from lead to lead while pulling upward on the part. The following extract from HP Service Note M-20E is a further aid for repairing etched circuit boards:

a. Don't apply excessive heat. Use a 37 to 48 watt soldering iron.

b. Clip the leads of the damaged component. Remove

the component and then unsolder the leads from the board.

c. Use a toothpick or other pointed object to clean the circuit board holes while heating with a soldering iron.

d. Shape the leads of replacement components to fit the circuit board holes. Don't use force.

e. If the metal plated conductive surface lifts from the board, cement it back with a small amount of quick-drying acetate-base cement with good insulating properties. Or, solder a wire along the damaged area.

Table 8-3. Schematic Diagram Notes.

Refer to MIL-STD-15-1A for schematic symbols not listed in this table.

= Etched circuit board

= Front panel marking

= Rear panel marking

= Front panel control

= Screwdriver adjustment

P/O = Part of

CW = Clockwise end of variable resistor

N C = No connection

= Waveform test point (with number)

= Common electrical point (with letter) not necessarily ground

= Single pin connector on board

= Pin of a plug-in board (with letter or number)

= Main signal path

= Primary feedback path

= Secondary feedback path

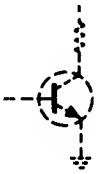
* = Optimum value selected at factory, average value shown; part may have been omitted.

= Field effect transistor (N-channel)

= Breakdown diode

= Tunnel diode

= Step recovery diode



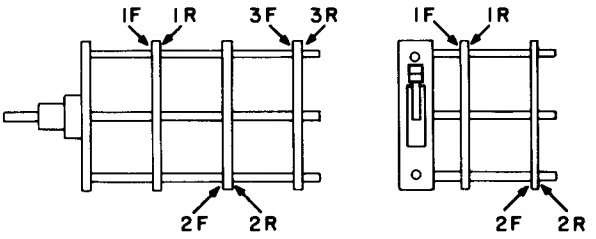
= Circuits or components drawn with dashed lines (phantom) show function only and are not intended to be complete. The circuit or component is shown in detail on another schematic.

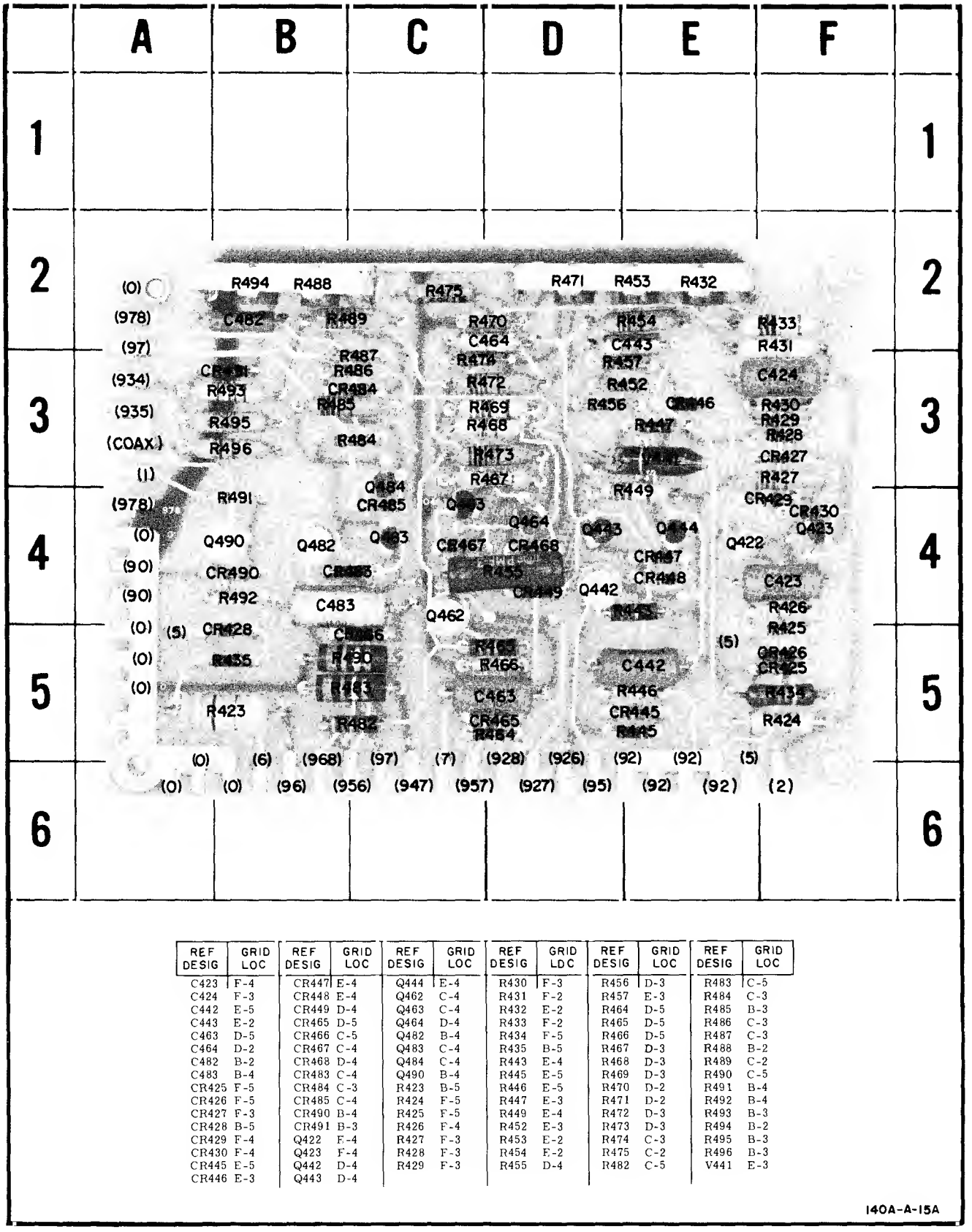
Unless otherwise indicated:
resistance in ohms
capacitance in picofarads
inductance in microhenries

Wire colors are given by numbers in parentheses using the resistor color code [(925) is wht-red-grn].

0 - Black	5 - Green
1 - Brown	6 - Blue
2 - Red	7 - Violet
3 - Orange	8 - Gray
4 - Yellow	9 - White

Switch wafers are identified as follows:

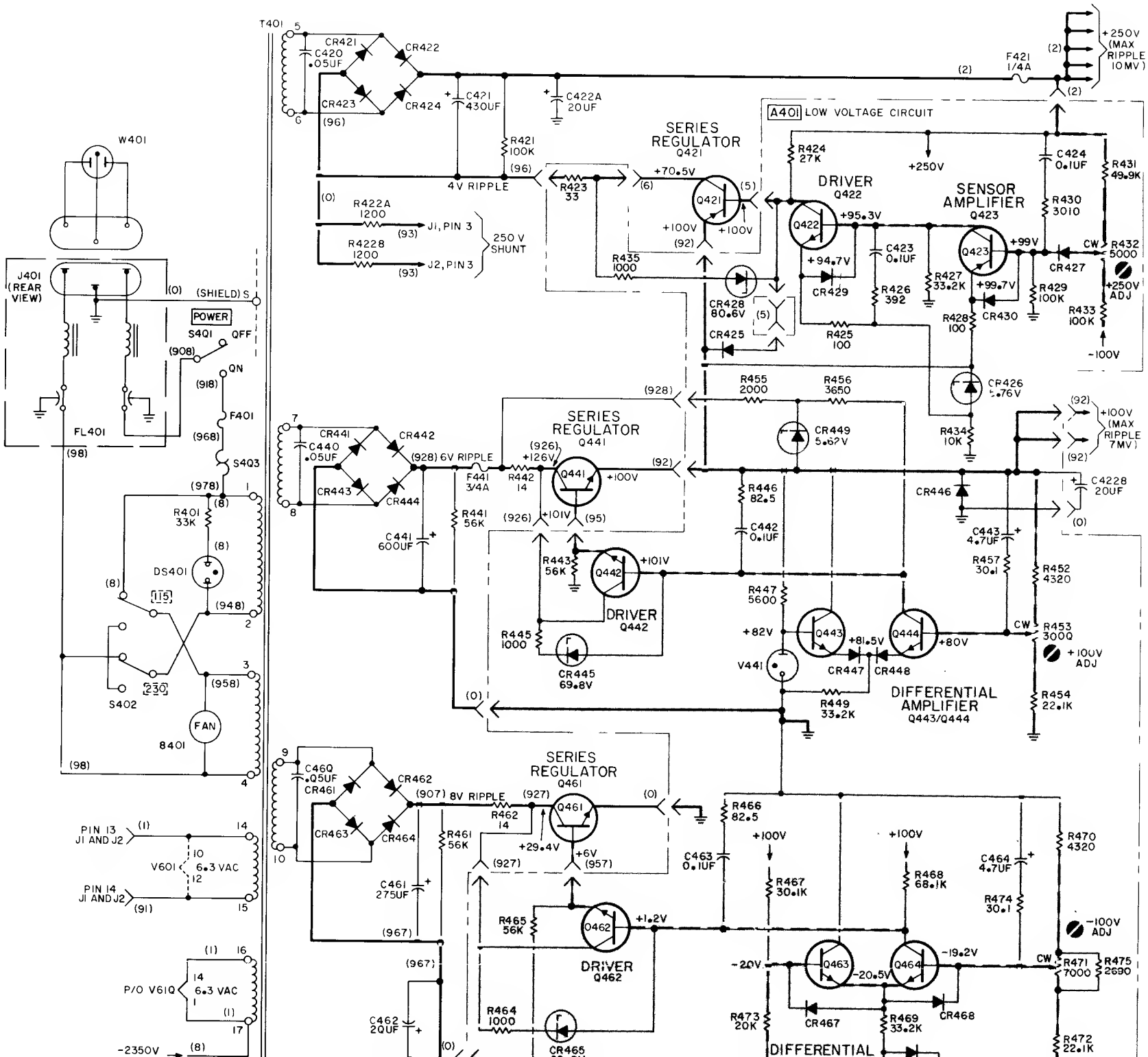


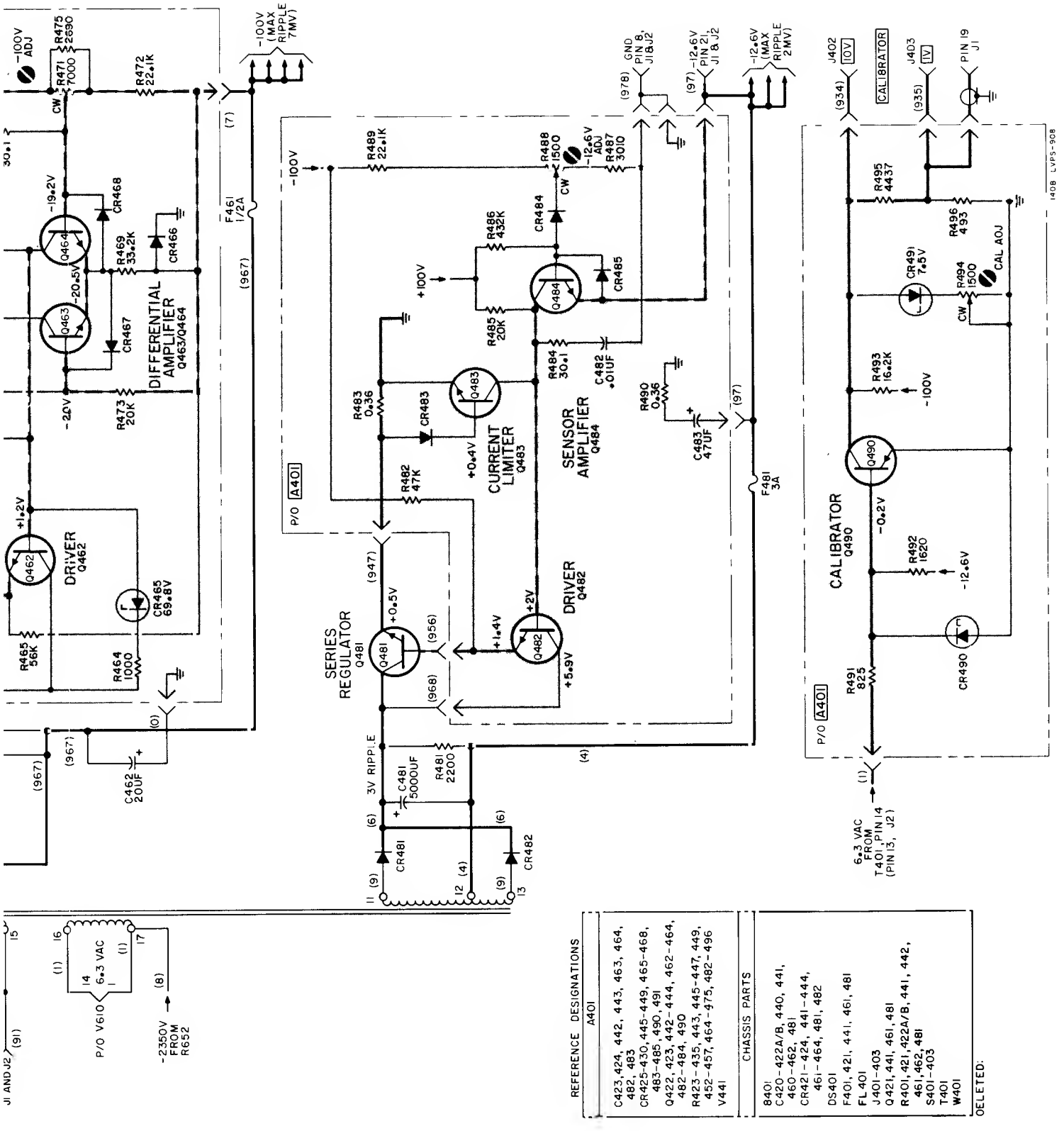


REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LDC	REF DESIG	GRID LOC	REF DESIG	GRID LOC
C423	F-4	CR447	E-4	Q444	E-4	R430	F-3	R456	D-3	R483	C-5
C424	F-3	CR448	E-4	Q462	C-4	R431	F-2	R457	E-3	R484	C-3
C442	E-5	CR449	D-4	Q463	C-4	R432	E-2	R464	D-5	R485	B-3
C443	E-2	CR465	D-5	Q464	D-4	R433	F-2	R465	D-5	R486	C-3
C463	D-5	CR466	C-5	Q482	B-4	R434	F-5	R466	D-5	R487	C-3
C464	D-2	CR467	C-4	Q483	C-4	R435	B-5	R467	D-3	R488	B-2
C482	B-2	CR468	D-4	Q484	C-4	R443	E-4	R468	D-3	R489	C-2
C483	B-4	CR483	C-4	Q490	B-4	R445	E-5	R469	D-3	R490	C-5
CR425	F-5	CR484	C-3	R423	B-5	R446	E-5	R470	D-2	R491	B-4
CR426	F-5	CR485	C-4	R424	F-5	R447	E-3	R471	D-2	R492	B-4
CR427	F-3	CR490	B-4	R425	F-5	R449	E-4	R472	D-3	R493	B-3
CR428	B-5	CR491	B-3	R426	F-4	R452	E-3	R473	D-3	R494	B-2
CR429	F-4	Q422	F-4	R427	F-3	R453	E-2	R474	C-3	R495	B-3
CR430	F-4	Q423	F-4	R428	F-3	R454	E-2	R475	C-2	R496	B-3
CR445	E-5	Q442	D-4	R429	F-3	R455	D-4	R482	C-5	V441	E-3
CR446	E-3	Q443	D-4								

140A-A-15A

Figure 8-3. Component Identification, Low Voltage Power Supply Board A401


T401
W401
J401 (REAR VIEW)
(0) (SHIELD) S
POWER
S401 QFF
(908)
QN
(918)
F401
(968)
FL401
(98)
S403
(978)
R401 33K
DS401
115
(948)
S402
230
(958)
FAN
8401
(98)
PIN 13 J1 AND J2
PIN 14 J1 AND J2
(91)
V601
6.3 VAC
P/O V610
-2350V
CR421
C420 .05UF
CR422
CR423
CR424
C421 430UF
C422A 20UF
(96)
R421 100K
4V RIPPLE
R422A 1200
R4228 1200
J1, PIN 3
J2, PIN 3
250 V SHUNT
SERIES REGULATOR Q421
R423 33
+70.5V
Q421
+100V
R435 1000
CR428 80.6V
CR425
F421 1/4A
+250V (MAX RIPPLE 10MV)
A401 LOW VOLTAGE CIRCUIT
R424 27K
+250V
DRIVER Q422
Q422
+95.3V
+94.7V
CR429
R426 392
C423 0.1UF
R425 100
SENSOR AMPLIFIER Q423
Q423
+99V
+99.7V
CR430
R427 33.2K
R428 100
R429 100K
C424 0.1UF
R430 3010
R431 49.9K
CR427
R432 5000
+250V ADJ
R433 100K
-100V
CR426 5.76V
R455 2000
R456 3650
CR449 5.62V
R434 10K
+100V (MAX RIPPLE 7MV)
C4228 20UF
CR446
C443 4.7UF
R457 30.1
R452 4320
R453 3000
+100V ADJ
R454 22.1K
SERIES REGULATOR Q441
CR441
C440 .05UF
CR442
CR443
CR444
6V RIPPLE
F441 3/4A
R442 14
+126V
Q441
+100V
+101V
R441 56K
C441 600UF
R446 82.5
C442 0.1UF
R443 56K
Q442
DRIVER Q442
R445 1000
CR445 69.8V
R447 5600
+82V
Q443
Q444
+81.5V
+80V
CR447
CR448
V441
R449 33.2K
DIFFERENTIAL AMPLIFIER Q443/Q444
SERIES REGULATOR Q461
C460 .05UF
CR461
CR462
CR463
CR464
8V RIPPLE
R462 14
Q461
+29.4V
+6V
R461 56K
C461 275UF
R466 82.5
C463 0.1UF
+100V
R467 30.1K
R468 68.1K
C464 4.7UF
R474 30.1
R470 4320
-100V ADJ
R465 56K
Q462
DRIVER Q462
+1.2V
-20V
Q463
Q464
-19.2V
-20.5V
CR467
CR468
R471 7000
R475 2690
R473 20K
R469 33.2K
R464 1000
CR465
C462 2QUF
R472 22.1K
DIFFERENTIAL



REFERENCE DESIGNATIONS A401
C423, 424, 442, 443, 463, 464, 482, 483
CR425-430, 445-449, 465-468, 483-485, 490, 491
Q422, 423, 442-444, 462-464, 482-484, 490
R423-435, 443, 445-447, 449, 452-457, 464-475, 482-496
V441

CHASSIS PARTS
B401
C420-422A/B, 440, 441, 460-462, 481
CR421-424, 441-444, 461-464, 481, 482
DS401
F401, 421, 441, 461, 481
FL401
J401-403
Q421, 441, 461, 481
R401, 421, 422A/B, 441, 442, 461, 462, 481
S401-403
T401
W401
DELETED:

Figure 8-4. Low Voltage Power Supply Schematic Diagram

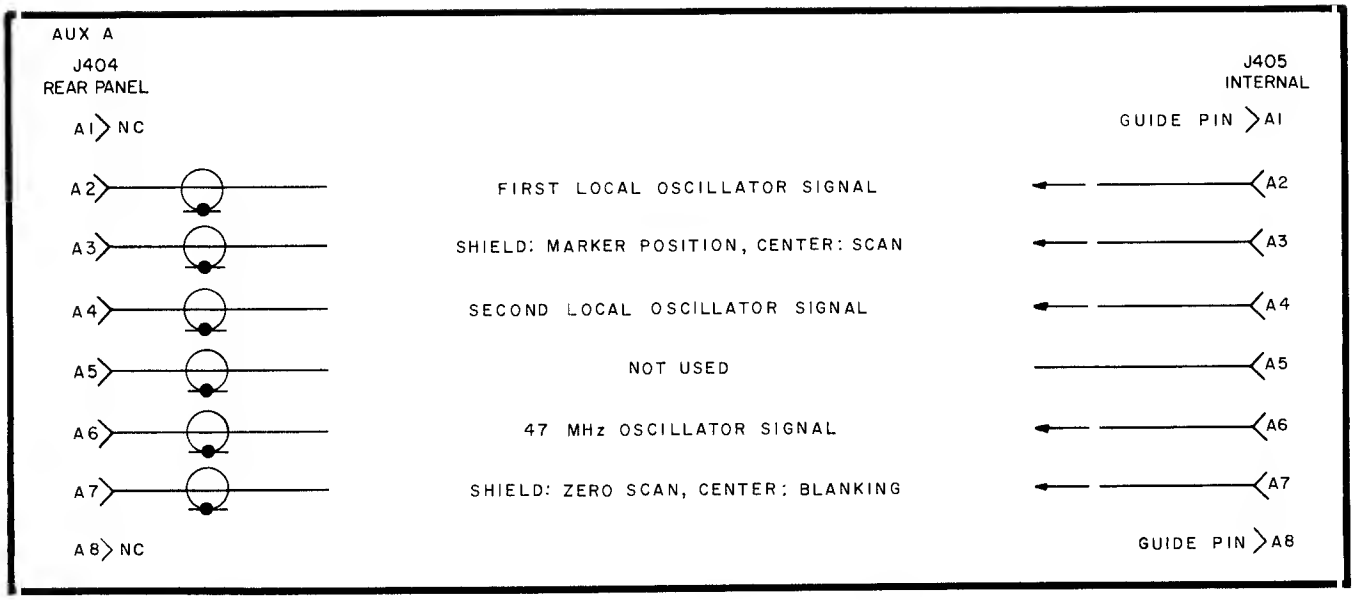


Figure 8-5. Spectrum Analyzer Accessory Cable

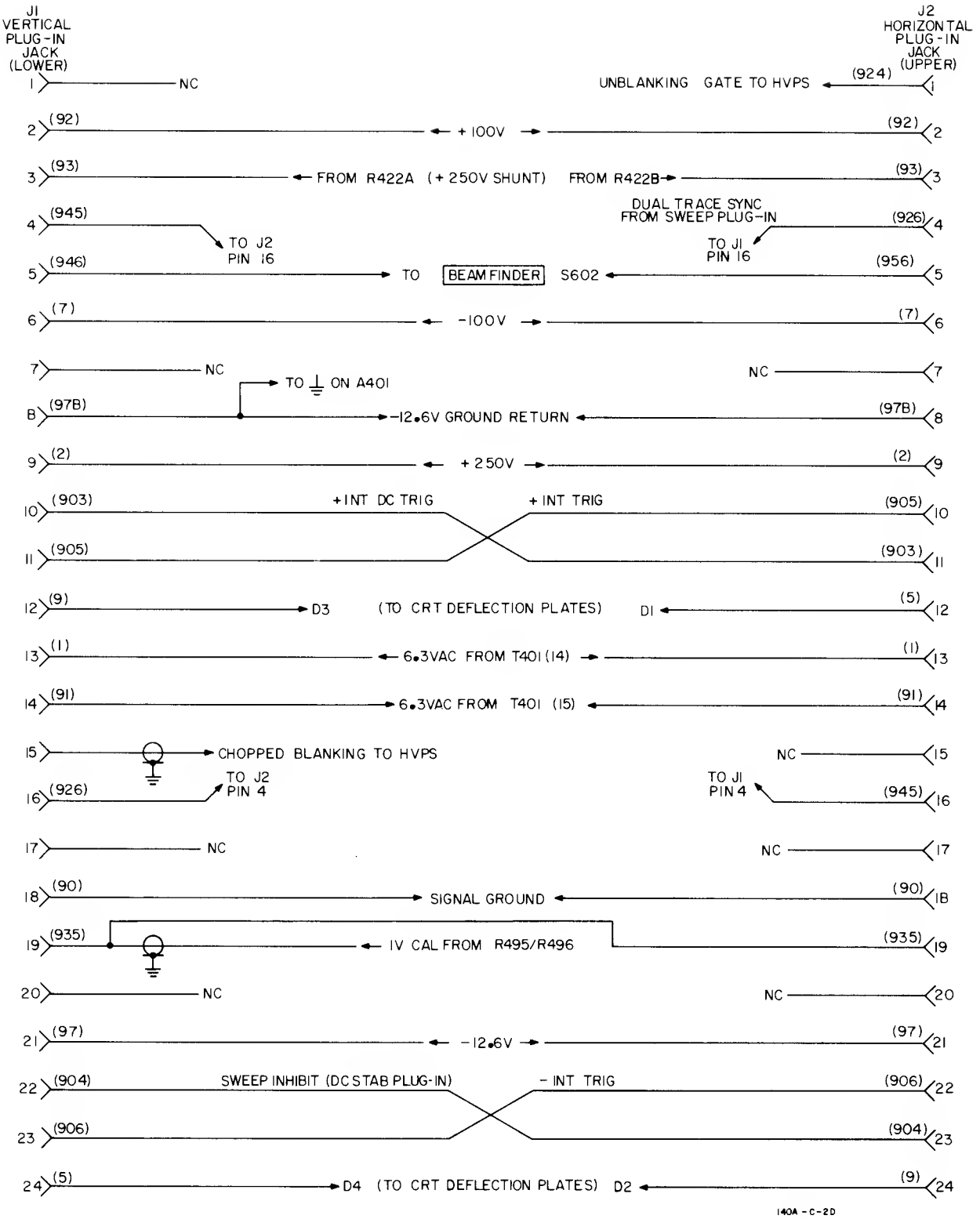
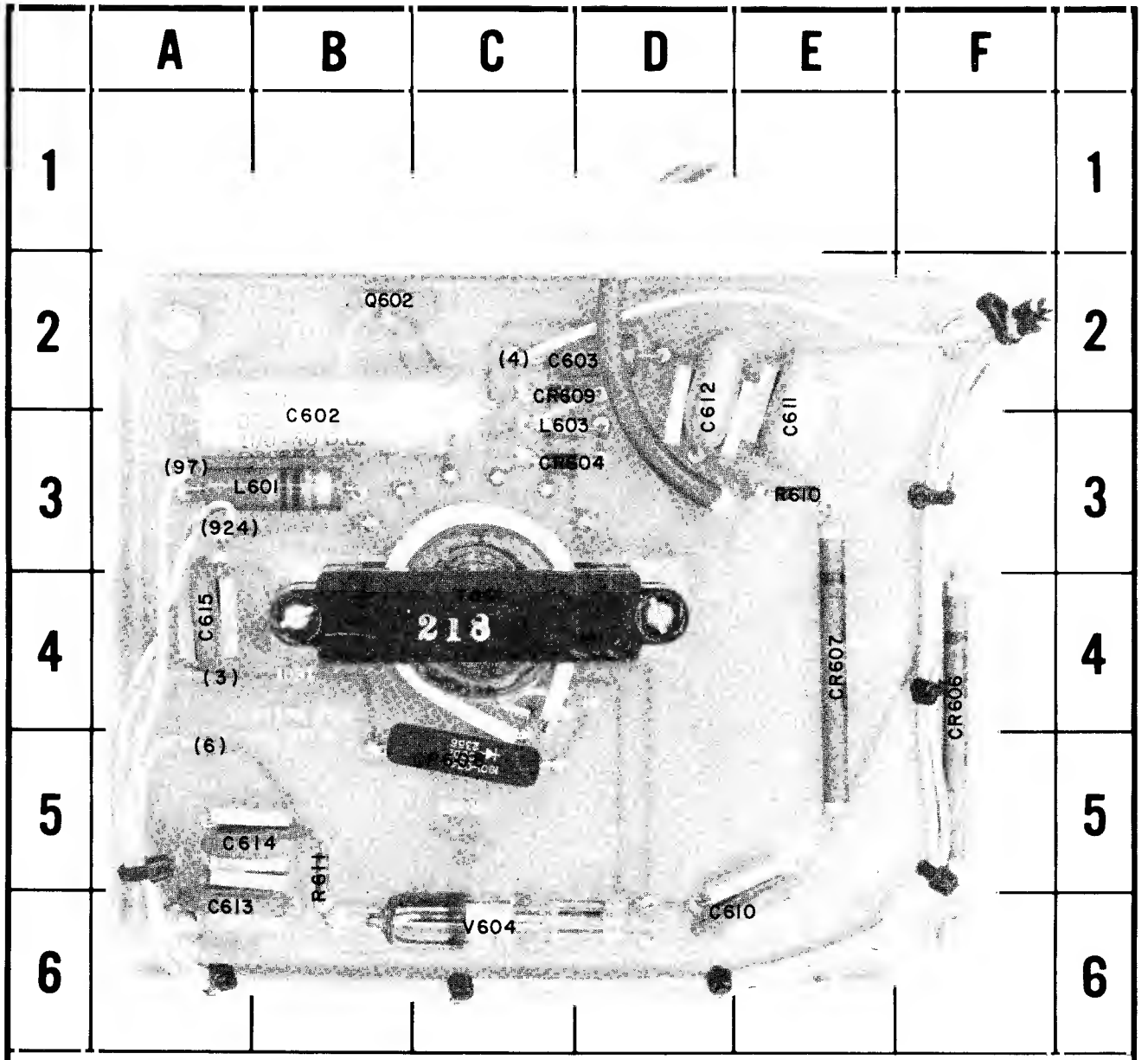
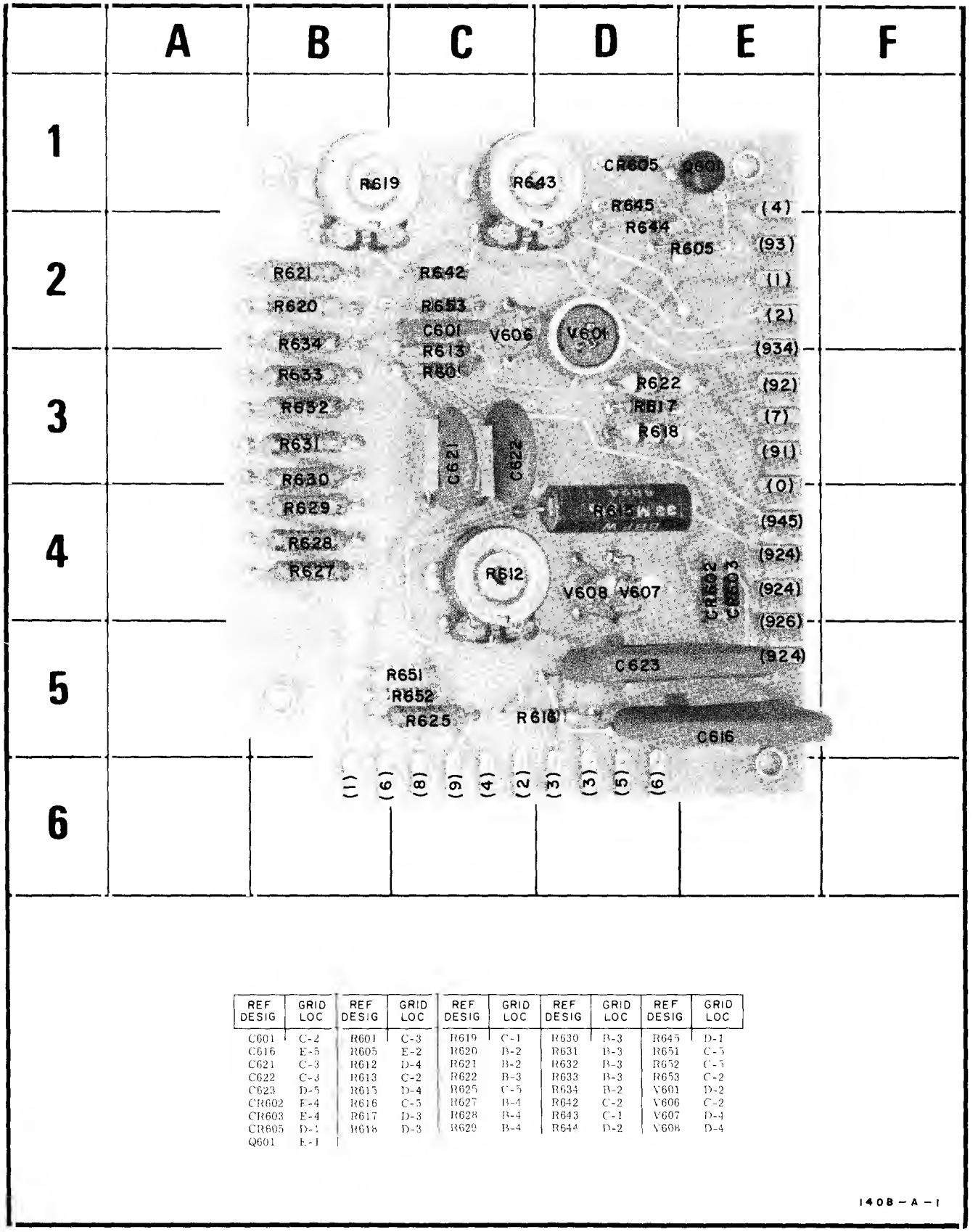


Figure 8-6. Plug-In Jack Connections



REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC
C602	B-3	C613	A-6	CR607	E-4	Q602	B-2
C603	D-2	C614	B-5	CR608	C-5	R610	E-3
C610	E-6	C615	A-3	CR609	C-2	R611	B-5
C611	E-2	CR604	C-3	L601	B-3	T601	C-4
C612	D-2	CR606	F-4	L603	D-3	V604	C-6

Figure 8-7. Component Identification, High Voltage Rectifier Deck and Board A601



REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC
C601	C-2	R601	C-3	R619	C-1	R630	B-3	R645	D-1
C616	E-5	R605	E-2	R620	B-2	R631	B-3	R651	C-5
C621	C-3	R612	D-4	R621	B-2	R632	B-3	R652	C-5
C622	C-3	R613	C-2	R622	B-3	R633	B-3	R653	C-2
C623	D-5	R615	D-4	R625	C-5	R634	B-2	V601	D-2
CR602	E-4	R616	C-5	R627	B-4	R642	C-2	V606	C-2
CR603	E-4	R617	D-3	R628	B-4	R643	C-1	V607	D-4
CR605	D-1	R618	D-3	R629	B-4	R644	D-2	V608	D-4
Q601	E-1								

1408-A-1

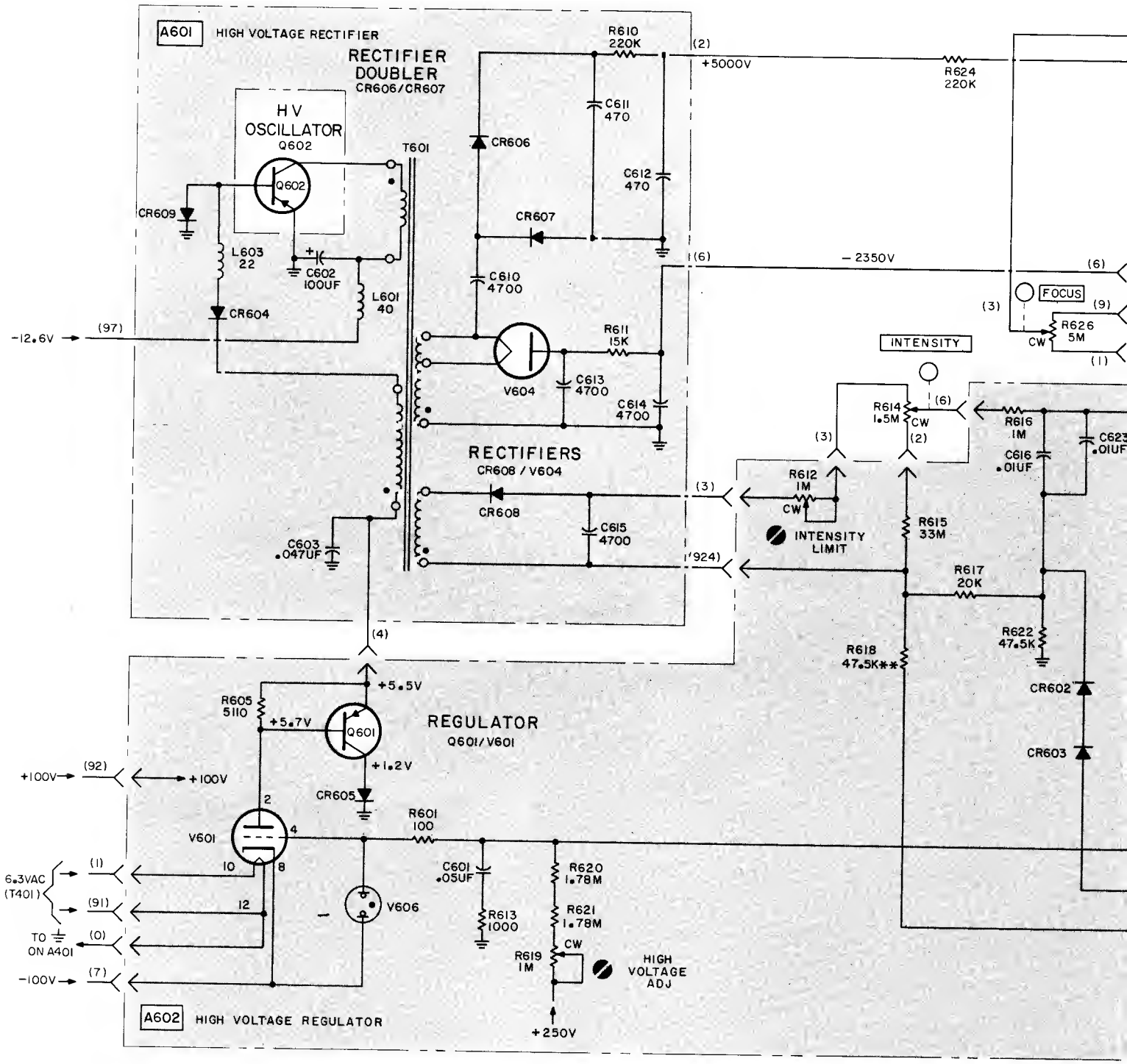
Figure 8-8. Component Identification, High Voltage Regulator Board A602

REFERENCE DESIGNATIONS

A601	A602	CHASSIS PARTS
C602,603,610-615 CR604,606-609 L601,603 R610,611 T601 V604	C601,616,621-623 CR602,603,605 Q601 R601,605,612,613,615-622,625,R27-R634,642-645,651,652 V601,606-608	L602 Q602 R614,624,626,641,650 S601,602 TP601 V610

DELETED:

** OMITTED IN INSTRUMENTS WITH A PII PHOSPHOR CRT



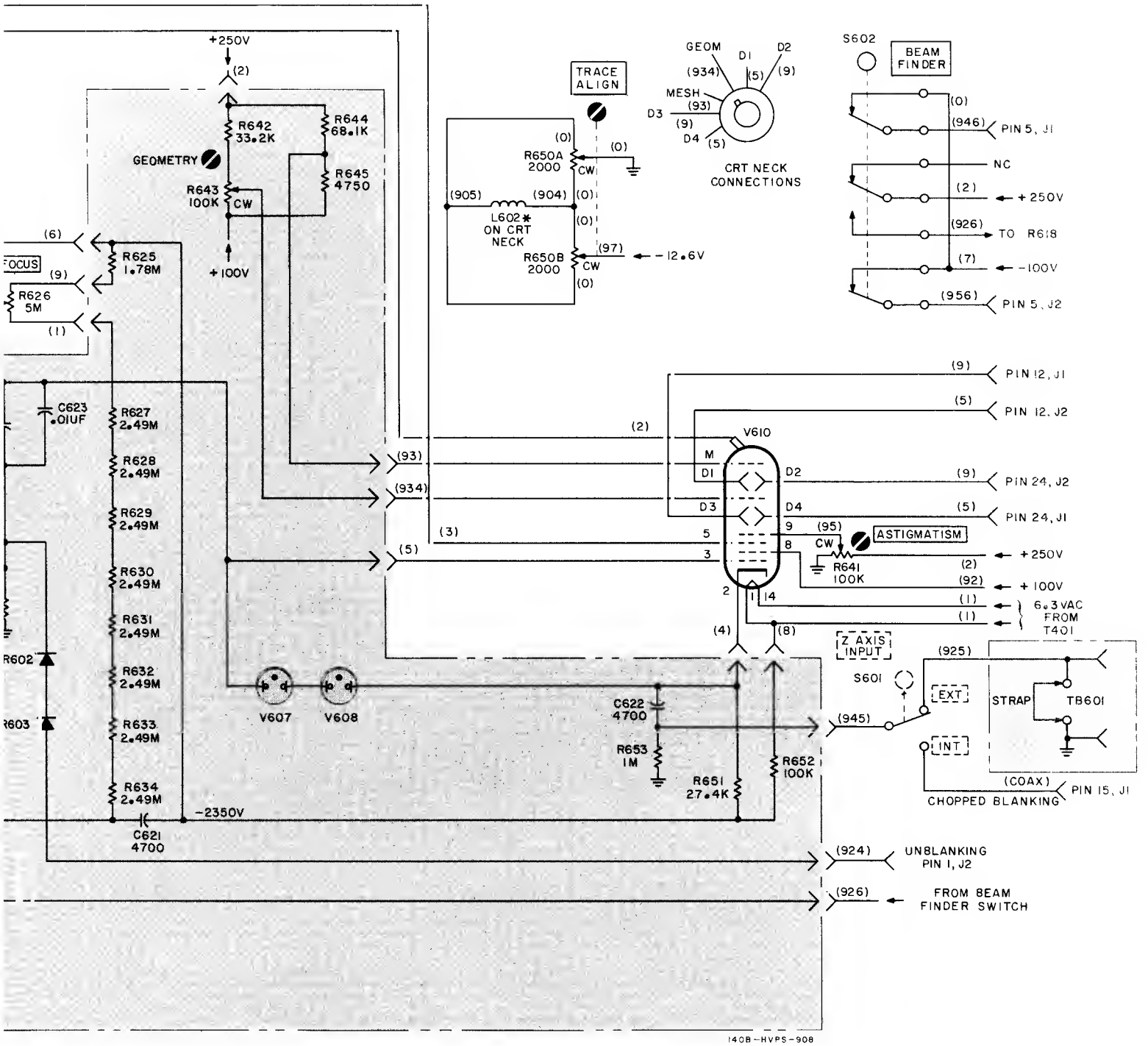


Figure 8-9. High Voltage Power Supply Schematic Diagram

CATHODE-RAY TUBE WARRANTY

The cathode-ray tube (CRT) supplied in your Hewlett-Packard Oscilloscope and replacement CRT's purchased from hp are warranted by the Hewlett-Packard Company against electrical failure for a period of one year from the date of sale. Broken tubes and tubes with phosphor or mesh burns are not included under this warranty. If the CRT is broken when received, a claim should be made with the responsible carrier.

Your nearest Hewlett-Packard Sales/Service Office (listed at rear of instrument manual) maintains a stock of replacement tubes and will assist in processing the warranty claim.

We would like to evaluate every defective CRT. This engineering evaluation helps us to provide a better product for you. Please fill out the CRT Failure Report on the reverse side of this sheet and return it with the defective CRT to:

Hewlett-Packard Company
1900 Garden of the Gods Road
Colorado Springs, Colorado 80907

Attention: CRT QA

To avoid damage to the tube while in shipment, please follow the shipping instructions below; warranty credit is not allowed on broken tubes.

SHIPPING INSTRUCTIONS

It is preferable that the defective CRT be returned in the replacement CRT carton. If the carton or packaging material is not available, pack the CRT according to the instructions below:

1. Carefully wrap the tube in 1/4 inch thick cotton batting or other soft padding material.

2. Wrap the above in heavy kraft paper.

3. Pack wrapped tube in a rigid container which is at least 4 inches larger than the tube in each dimension.

4. Surround the tube with at least 4 inches of packed excelsior or similar shock absorbing material; be sure the packing is tight all around the tube.

Thank you,

CRT Department

CATHODE-RAY TUBE FAILURE REPORT

DATE _____

FROM:

NAME _____

COMPANY _____

ADDRESS _____

1. hp INSTRUMENT MODEL NO. _____
2. hp INSTRUMENT SERIAL NO. _____
3. CRT SERIAL NO. _____
4. Please describe the failure and, if possible, show the trouble on the appropriate CRT face below.

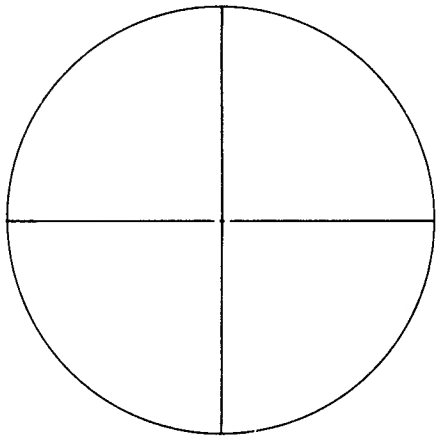
_____

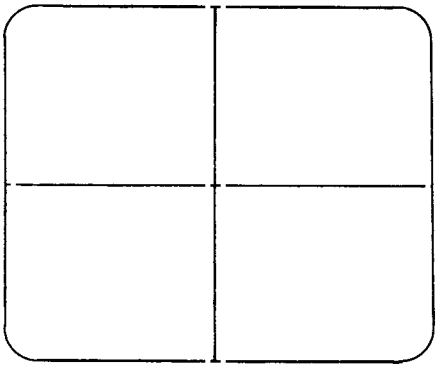
_____

_____

_____

_____





5. Is the CRT within warranty? Yes_____ No_____
6. hp Sales/Service Office _____ Repair Order No. _____

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00140-90910

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K4XL's  BAMA

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